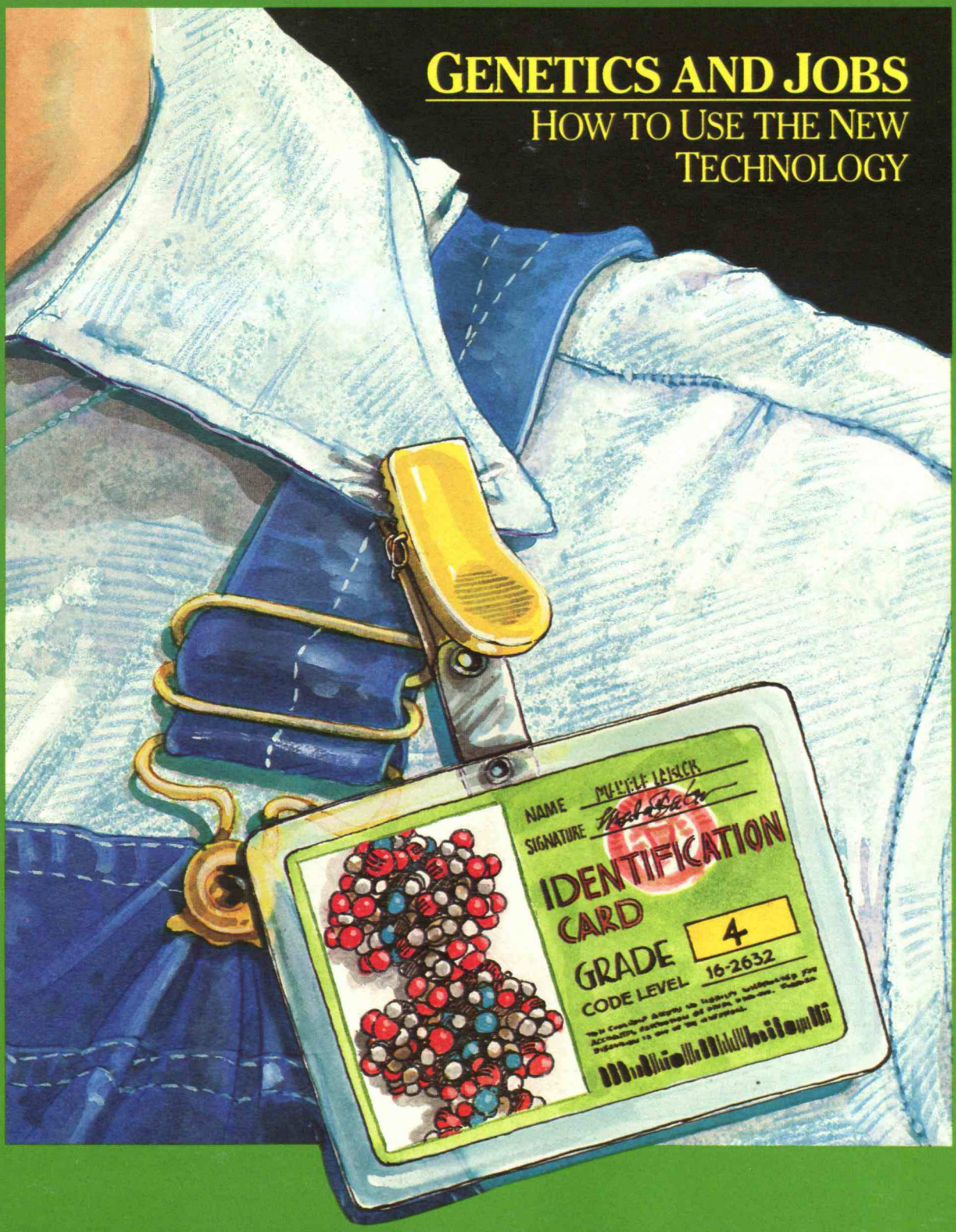
NATO'S NEWEST WEAPONS DEBATE □ MBAs VS PHDs IN BIOTECH

TechnologyReview

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY MAY/JUNE 1985 $3.00



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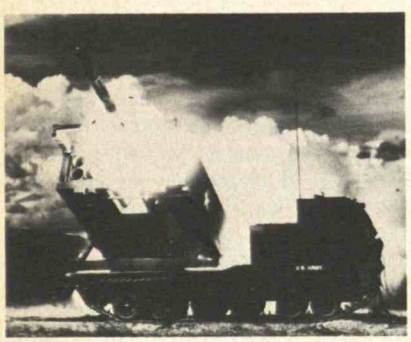

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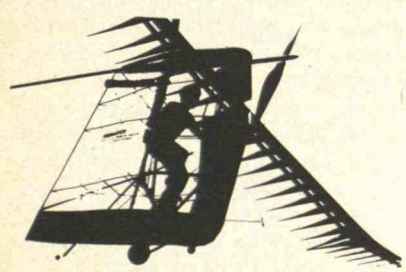

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The Great Debate over Antisatellite Weapons

Kosta Tsipis and Eric Raiten provide an inaccurate historical introduction in "Antisatellite Weapons: The Present Danger" (*August/September, page 54*). They assert that the Ajax missile could carry a nuclear warhead 100 to 150 miles above the earth's surface; that Ajax was originally intended as an antiballistic weapon but was modified to operate as an antisatellite weapon; and that Ajax was superseded in 1963 by the Thor intermediate-range ballistic missile.

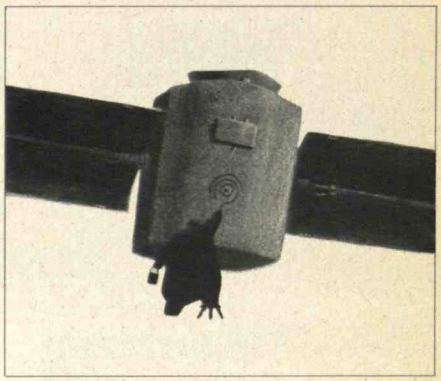
In fact, the Ajax was guided by radio frequencies from the ground and had an effective slant range of approximately 25 miles. It would have been hard-pressed to achieve an altitude of 20 miles.

Ajax was originally conceived and deployed as an anti-aircraft surface-to-air missile (SAM) system. Its mission was to protect cities and military installations from bombers. Ajax could not have been modified to function as either an anti-ballistic missile or an antisatellite weapon before its deployment in 1953. Finally, Nike Ajax was not superseded by the Thor. Rather, the Ajax was replaced by another anti-aircraft SAM in the Nike series, the Nike Hercules.

The United States has never deployed an ASAT system. Although the Satellite Interceptor (SAINT) program was funded, and the air force did attempt to use the Thor as a launch vehicle, this effort was not successful. The authors' assertion that SAINT existed as an ASAT program in 1957 seems especially questionable given the fact that *Sputnik 1* was not launched until October 4, 1957 and *Explorer 1* was not launched until January 31, 1958.

Laurence B. Berger
Marblehead, Mass.

The greatest obstacle to serious negotiations on antisatellite weapons is not government intransigence, but rather the myths promoted by Soviet spokesmen and Western "space freeze" advocates. For example, Tsipis' and Raiten's assertion that the current Soviet "killer satellite" is "unreliable . . . (with) a success rate of only 50 percent" is deliberate deception. The 20-odd Soviet ASAT tests have used a variety of advanced attack trajectories and sensors. Half of the four tests of the standard radar-guided system from 1968 to 1970 were successful, and the system was considered "operational." Advanced systems tested since the latter half of the 1970s have not worked well. But all six



of the standard ASAT weapons injected into proper orbits have scored "kills."

Nor has the Soviet Union ever promised "not to perform any more ASAT tests," as the authors suggest. Of course, spokesmen from Chernenko on down have vowed that the USSR has never tested such weapons and that the "killer satellite" is a "Pentagon myth." Such Soviet deception makes substantive discussion of the topic highly unlikely.

A major dispute centers around the question of whether the U.S. ASAT currently being developed could attack Soviet early-warning satellites. Although these satellites can dip to within 600 kilometers of the earth, they do so only over the far Southern Pacific and Atlantic Oceans. This is far out of the current range of the F-15, which launches the ASAT. The authors' allegation is therefore alarmist.

Tsipis' and Raiten's statement that satellites in geosynchronous orbits would not be visible from most of the Soviet Union is false; most of the populated regions are well within range. The authors also omit the fact that the Soviets do have a network of geosynchronous satellites that, while primarily civilian, would certainly be commandeered by military forces in wartime. The authors' assertion that the "United States would probably develop an ASAT capable of destroying satellites in geosynchronous orbit before the Soviet Union" makes no sense if there are no Soviet military targets in such an orbit.

Since U.S. satellite launchings occur much less frequently than Soviet launchings, restoring orbital reconnaissance after an ASAT attack could take months. Satellites do more than merely "locate" Soviet physical facilities, so this blindness would have immense strategic significance.

Until partisans on this issue start speak-

Continued on page 78

ILLUSTRATION: ROB COLVIN

GIVE HER A DIAMOND TO SET HER WORLD ON FIRE.

The necklace shown features a quality diamond of 2.02 carats.

De Beers

Every quality diamond of a carat or more is one of nature's rarest and most exquisite phenomena. Each is a visible reflection of you. Unique in all the world, possessing four vital qualities that set it apart forever. They are called the 4C's: Cut, Color, Clarity and Carat-weight. It is the 4C characteristics that determine the value of a diamond—and to an astonishing degree the beauty and value of your jewelry—no matter what the design.

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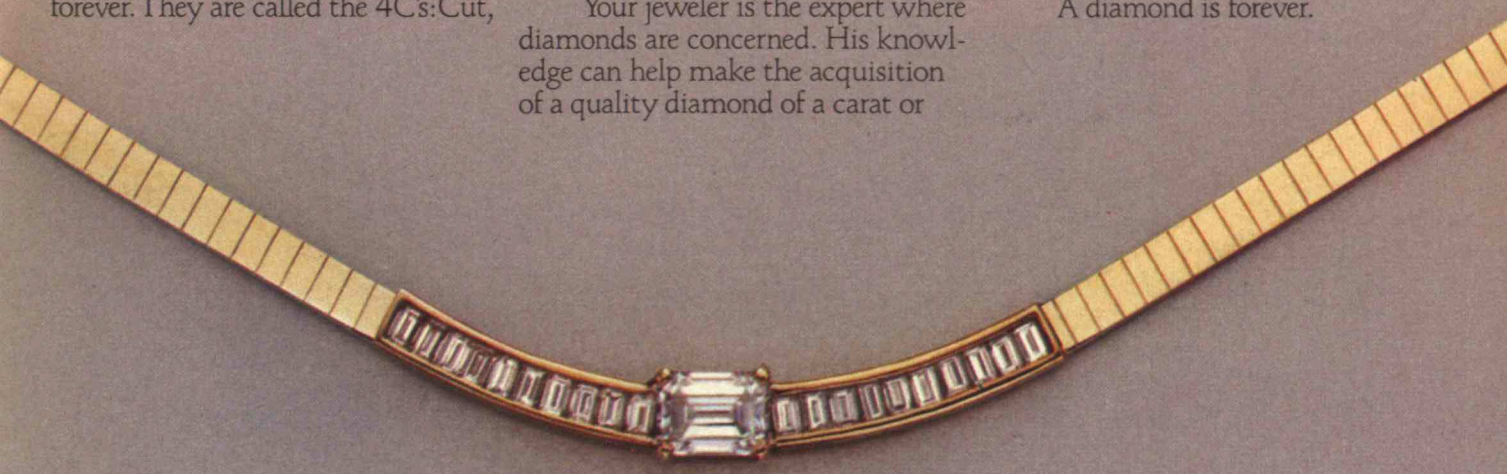
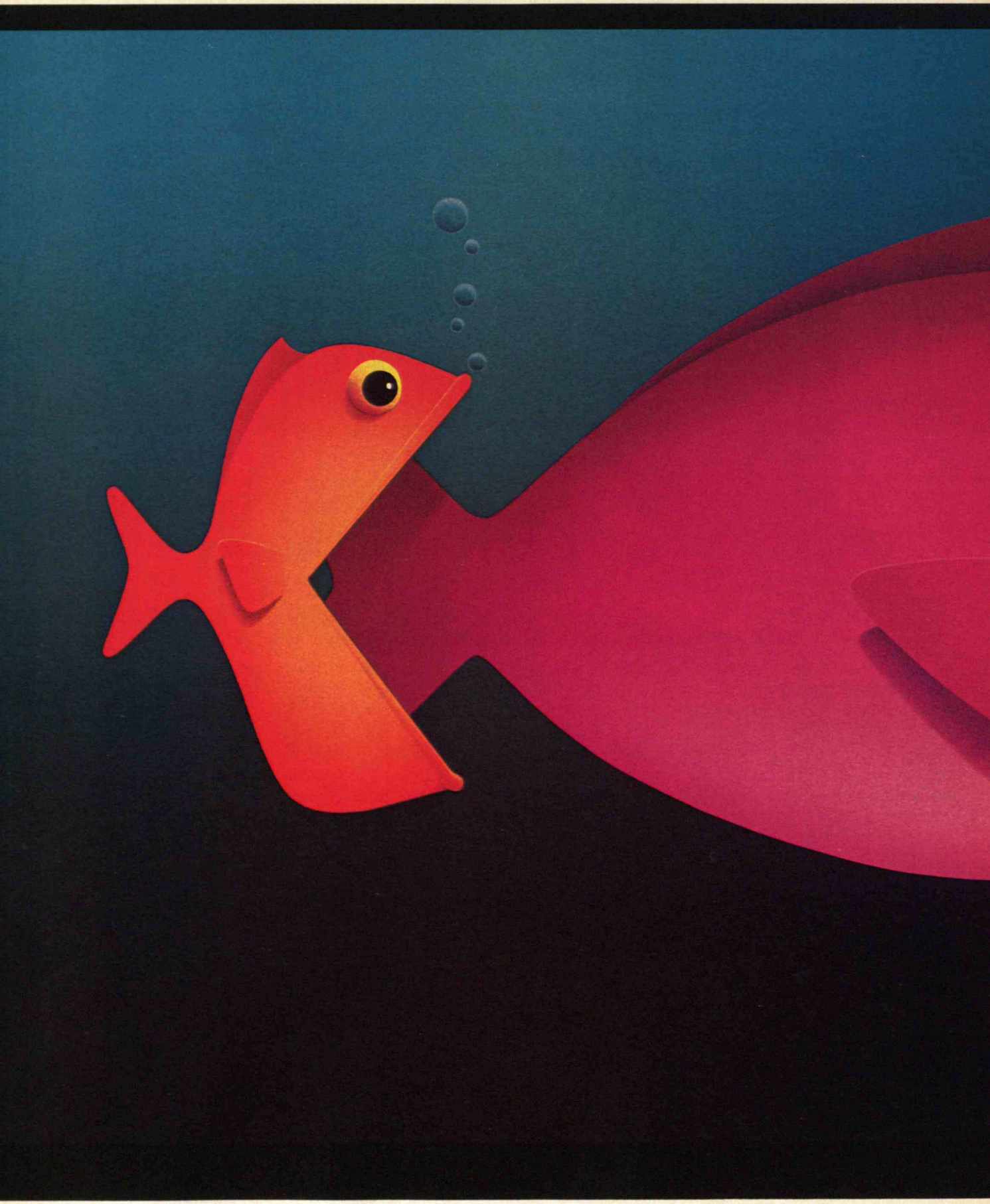
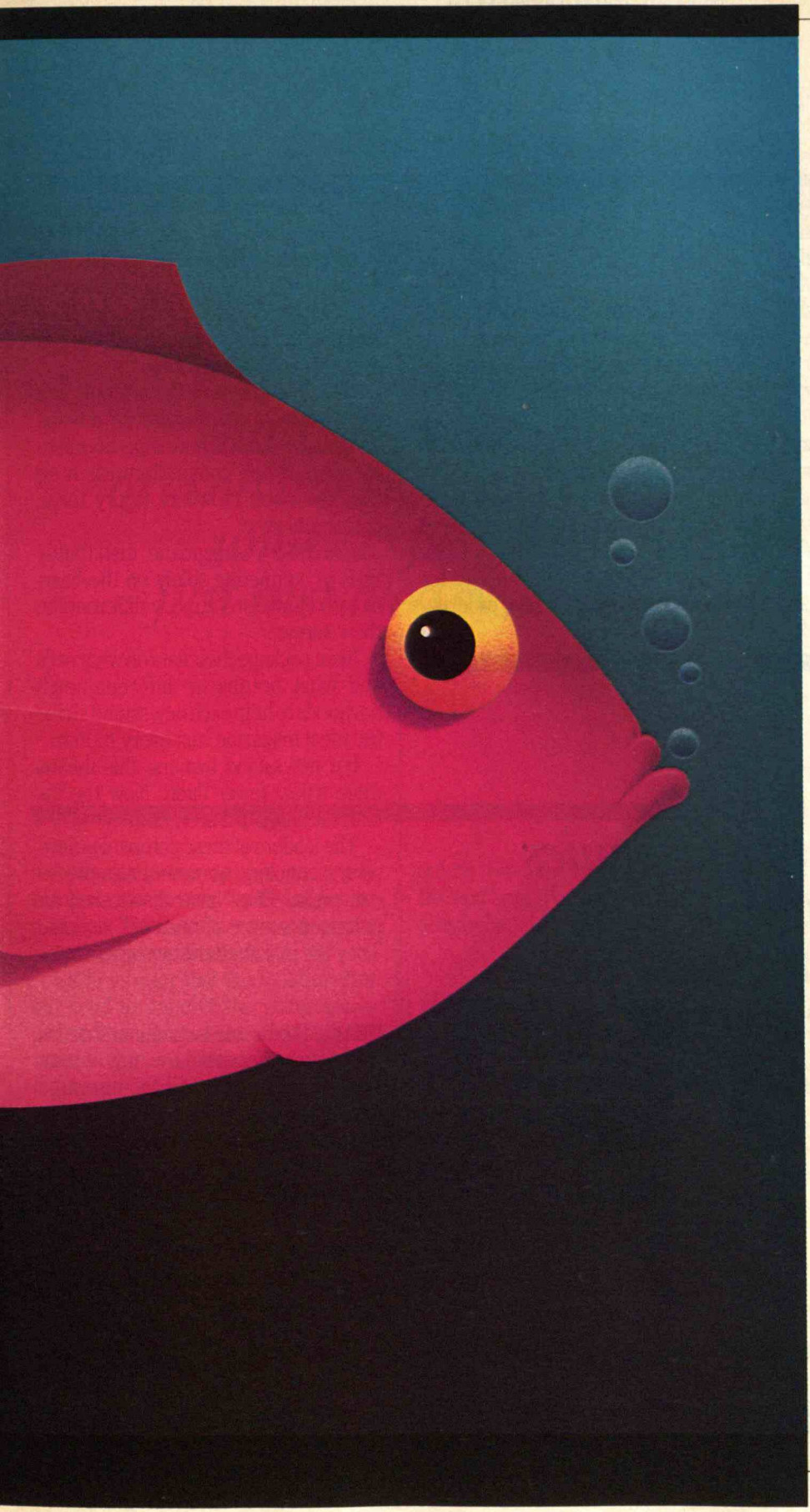
Give her a quality diamond of a carat or more. A truly rare and beautiful gift. Like the woman you love.

A diamond is forever.



A QUALITY DIAMOND OF A CARAT OR MORE.
A FIRE RARELY SEEN.





HOW THE COMPETITION IS PLANNING TO STEAL YOUR CUSTOMERS

At first, the new office automation system was a big hit. It paid for itself in the first 18 months.

But today the faces around the boardroom table are glum.

While this company was investing a fortune to become more efficient, a smaller competitor was spending half as much to make itself more *effective*.

Now the ambitious David is stealing the efficient Goliath's customers.

This year American business will invest $141 billion in computers and communications gear.

The lion's share will go for systems that automate routine office chores,

continued on next page

continued from preceding page

boosting productivity, reducing costs.

But efficiency is only one side of the coin.

Admits one manager: "Most of us are too busy counting the beans on our desks to think about how these new systems might *change the way we compete.*"

The problem is that it's a lot easier to think about your business as it is, than to imagine your business *as it could be.*

Enter AT&T Information Systems. We earn our pay by helping companies use technology to achieve their objectives – whatever those objectives are.

Below are a few ideas to start your competitive juices flowing.

◇

CATAPULT. Bean counters beware! Right now, a handful of companies are quietly rewriting the business school casebooks by using information systems to gain a strategic advantage.

Even smaller companies have found in these systems the means to deliver added-value services at little cost, and to catapult themselves into new fields of opportunity.

Example: A drug company leases terminals to pharmacies to save ordering costs. Idea: use the same system to process pharmaceutical *insurance* data for druggists – at a 5% commission. Result: more revenue, closer ties with customers, a broader business base.

Example: A brokerage firm installs a system that links 3 ho-hum investments into a splashy new service.

The resulting synergy not only captures a host of new customers, it helps keep them. Each is now *triply* bound to the firm. When competitors catch up, they will need crowbars to pry these customers away.

Example: A magazine distributor tires of competing solely on the basis of *cost.* How else can they differentiate their service?

Idea: package their data on what sells and what bombs in different neighborhoods to help each newsstand strike the ideal magazine mix every month.

For newsstand owners, this means more sales, fewer duds. Now the distributor charges a premium.

The leaders of these companies have seen technology as more than a way to cut costs. They have discovered an untapped source of business leverage. They are making their own lightning.

◇

DEALS. The business machines that can work such wonders are now within reach of virtually any company with a working checkbook. So how is it that *every* ambitious company hasn't installed a few whizbangs and made business lightning strike?

Answer: technology is only as good as the goals you set for it.

At AT&T it is gospel that *business strategy dictates system design.* (It is no accident that 2,800 of our Account Executives are specialists in particular

> ***A handful of companies are rewriting the business school casebooks by using information systems to gain a strategic advantage.***

> ***Business imperatives have a nasty way of evolving right out from under expensive, just-installed systems.***

industries.) In our opinion, too many companies keep their "Systems" people and their "Business" people in separate, watertight compartments.

Little wonder that the systems they buy tend to improve the status quo – rather than propel the company forward. It is the difference between buying a system to process your salespeople's expense reports ... vs. one that helps them close more deals.

Free offer: Not every manager has a corps of information specialists on tap. How, then, do you gauge the competitive opportunities today's technology holds for your company?

Recently, we ran across an article in the *Harvard Business Review* that can help you see your choices clearly – before you call in the vendors. It is objective and brief. For a free reprint, please telephone 1-800-247-1212.

◇

ADVERTISEMENT. Business leaders often complain that the high priests of technology are too gung-ho for *change,* that new systems become old systems too fast.

Just as often, it is the company itself that has changed. Business imperatives have a nasty way of evolving right out from under an expensive, just-installed system.

Enter AT&T. Recent changes in the way our company competes have spurred us to devise a new approach to office automation. Result: a "systems architecture" that makes change work *for* business – instead of against.

The briefing books on AT&T's new Information Systems Architecture are heavy going for non-technical types. Most ask for the capsule version.

Here it is.

Instead of pinning our hopes on a particular kind of business machine, AT&T is creating a set of high-tech "building blocks." *A system of systems* in which office machines are virtually interchangeable. And in which old hardware can easily learn new "tricks" as business needs change.

In AT&T's world, no company need choose between a system created to boost productivity vs. another that promises a competitive edge.

As a customer of the new AT&T, you can expect to find much of what you will need for *any* job among the AT&T machines you order today.

Your technical wizards will tell you this: "If AT&T can do what they claim, our company stands to save a ton of money."

Our technical wizards like to think they can help you *make* a ton of money.

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MARSHALL GOLDMAN

How Big Corporations Can Think "Small"

MANAGEMENT consultants argue continuously about the optimum size of the corporation. When is a company too small? When is it too big? At what point do economies of scale become diseconomies? For many years, the conventional wisdom seemed to be that there are few, if any, limits to corporate size; the more mergers the merrier. After all, a corporation with a large sales volume and asset base can more profitably sustain a support staff and sophisticated research facilities. And the broader the base, the more money there usually is to spend on talent and employee benefits. Finally, larger firms typically have more capital resources to draw upon and are therefore less dependent on the whims of bankers and outside lenders.

However, many corporations are having second thoughts about whether bigger is always better. Some firms have actually begun to divest themselves of their more marginal interests. ITT is a classic example. In the 1970s, under Chairman Harold Geneen, the company could not expand fast enough. Now it is shedding subsidiaries almost as quickly under his successor, Rand Araskog.

One reason for such divestment is management's concern that the conglomerate has become too diversified. Top managers may feel that many subsidiaries acquired over the years bear little or no relationship to their company's main areas of expertise. As a result, these subsidiaries do not receive the expert attention they need and often become less profitable than before they were acquired. Moreover, more often than not, there is no advantage in maintaining a jointly staffed laboratory and central headquarters staff for a wide diversity of products and needs.

Divestiture, of course, is not an answer for all corporations. Some such as IBM and General Motors have taken a different and, in some ways, bolder approach. They have attempted to recreate the flexibility and entrepreneurial spirit of small startup firms within their existing companies.

Large corporate structures are particularly vulnerable in those industries whose products depend on rapidly changing technology. The life cycle of particular products in such industries is usually not much more than two to three years. To be competitive, firms must constantly develop new products or new models of existing products.

MARSHALL GOLDMAN IS PROFESSOR OF ECONOMICS AT WELLESLEY COLLEGE AND ASSOCIATE DIRECTOR OF THE RUSSIAN RESEARCH CENTER AT HARVARD UNIVERSITY.

Large firms are trying to recapture the entrepreneurial spirit by setting up independent subsidiaries.

In the United States, much product innovation has occurred in newly created firms. The number of new companies has also increased sharply in recent years. Whereas new incorporations totalled 264,000 in 1970 and 326,000 in 1975, their numbers reached 534,000 in 1980 and jumped to 582,000 in 1981—not even an especially prosperous year. Admittedly, these figures encompass more than manufacturing operations, and they are probably partly the result of significant reductions in the capital-gains tax. But the sharp increase in startup companies also reflects the flowering of a new entrepreneurial spirit.

These new companies and the emergence of new high-technology goods seem meant for each other. Given the short lifetime of new products, speed and flexibility are essential, and newly created enterprises can often respond faster than older, more established firms.

Beating Corporate Bureaucracy

While flexibility in developing new products is possible in these smaller startup firms, it obviously runs counter to the operating style of larger, more established corporations. Companies, like other organizations, tend to build up thicker and thicker layers of control and coordination over time. Committees proliferate and decisions become more ponderous. The larger the firm, the harder it is for the chief executive officer to personally monitor what is happening. Unlike the president of a newborn firm, the president of an established corporation must delegate authority to intermediate levels of management.

In a company with many managerial layers, the process of winning approval for new ideas is a time-consuming and ultimately enervating task. No wonder many managers become discouraged and their actions ritualized rather than energized. In a sense, this hardening of the administrative arteries is only natural, since managers of well-established enterprises have more to lose than their counterparts in newly created firms.

Recognizing the difficulty of stimulating innovation, several large corporations have set up brand-new, independent subsidiaries. IBM has been one of the boldest and most successful in adopting this technique. In the 1970s, IBM seemed unable to develop a successful microcomputer, in part because its research capabilities and marketing strategies were concentrated on large mainframe computers.

As firms such as Digital, Data General, Wang, and Apple began to command an ever-larger share of the exploding and lucrative microcomputer market, IBM decided that it would have to develop a competitive entry. And it would have to do so outside the company's existing R&D and manufacturing structure. After all, the production of a mass-market personal computer required a high-volume, low-cost process—quite different from the process used to build IBM's costly, customized mainframes.

IBM's solution was to create a special autonomous unit in Boca Raton, Fla., far removed from its headquarters in Ar-

ILLUSTRATION: BOB DAHM

monk, N.Y. The executives of this new division, dubbed an Independent Business Unit (IBU), were told to free themselves from the traditional IBM administrative, manufacturing, and marketing routines and start from scratch. Members of the group assumed total responsibility for designing and developing the IBM PC, as well as for its production, marketing, and sales—functions that are usually handled by different divisions at IBM. The unit also bypassed the company's often time-consuming review procedures, and its members were exempt from the typical round of corporate meetings.

The result was the highly profitable PC, which has given IBM a growing foothold in the microcomputer market. The same IBU subsequently produced the PCjr, which was widely criticized for its toylike keyboard and relatively high price tag. IBM developed a more professional-looking keyboard and reduced the price, and the company finally decided to stop production of the PCjr when sales continued to lag. However, top IBM management considers the IBU concept so successful that it has become standard operating procedure for developing other new product lines.

Starting from Scratch with Saturn

Other firms are considering a similar approach. General Motors recently announced that its new Saturn division will be disassociated from regular GM operations. Saturn will produce a new subcompact designed to be competitive in price and quality with small Japanese cars. GM has authorized Saturn executives to work out their own operating procedures, starting with a "clean sheet of paper," says GM spokesman Bill Winters. The new division will be capitalized with $5 billion and considered an independent but wholly owned subsidiary. Ultimately, its management will be accountable to GM's board of directors, but GM management is not expected to intervene in Saturn's day-to-day operations and investment decisions. GM hopes such autonomy will give birth not only to new modes of styling, engineering, production, and labor relations but also to a new organizational framework that will produce a better-quality car at lower cost. The United Auto Workers have so far accepted the necessity of this approach and have helped plan the production and labor procedures to be adopted at Saturn.

Given the size of GM and its past reliance on the hierarchical style of operations, top executives may find it difficult to relinquish control. And Saturn itself may have a hard time reinventing the wheel.

Yet even non-high-tech corporations are getting into the act. Concerned that its product designs have become "too rigid and deliberative," Levi-Strauss, the jean maker, has relocated some of its brightest management talent to smaller offices far removed from corporate headquarters. The hope is that once cast out of the prevailing corporate culture, these managers will generate the creativity and drive associated with less well established manufacturing environments.

It is unlikely that the large corporation will go the way of the dinosaur. But in competitive, fast-moving areas where new technology is crucial, the evolution of a new organizational form is key to firms' survival. The approach pioneered by IBM, GM, and Levi-Strauss may indeed be a way to stay big and stay on top. □

ROBERT C. COWEN

Forecasters in the Dock

It's fun to make fun of weather forecasters, especially when their predictions turn sour. But with "super radar" on TV weather shows, official government information available to anyone from U.S. Weather Radio, and a variety of weather data and maps accessible by home computers, it's easy for the public to believe that experts have a better handle on the weather than in fact they do.

Certainly Federal District Judge Joseph Tauro took forecasting exceptionally seriously last December 21. He found the National Oceanic and Atmospheric Administration (NOAA) legally liable for forecast quality when he judged that the agency had not adequately maintained one of two wind-sensing anemometers on an ocean buoy. The instrument had not been repaired for two and a half months after being hit by a ship.

The case involved four lobstermen lost at sea and presumed drowned on November 22, 1980, victims of an unexpected storm that suddenly threatened the Georges Bank area off Cape Cod. Relatives of three of the men sued NOAA because, they charged, the fishermen had relied on a forecast of good weather when they left Hyannis for the Bank.

Previous court rulings had held that NOAA's National Weather Service is not legally liable for inaccurate predictions. Nonetheless, Judge Tauro ruled that the service has a duty to ensure that its forecasts are as correct as possible. Thus he not only cited the repair delay, but also chided the service for not warning that its forecasts for the Georges Bank area were based on incomplete data. The Department of Justice is appealing the ruling.

If a disclaimer on incomplete data were to become standard, practically every forecast would have to carry one. It is a rare weather map, indeed, on which some data are not missing or considered unreliable.

The data come from a variety of satellites, ships, aircraft, and instrument buoys as well as the network of traditional weather-observing stations. Equipment at one or more sites may be temporarily out of service. Ships and aircraft come and go, with their data used on an "as available" basis. Sometimes a wind report or temperature or air-pressure reading may be so out of line with others from the surrounding area that meteorologists dismiss it as unreliable. Part of a forecaster's skill lies in knowing when to trust such information and when to ignore it in the context of all the other data available for that forecast period.

The public has an idealized view of the validity of weather forecasts.

A critical point that Judge Tauro seemed to misunderstand is that wind data from the Georges Bank buoy wouldn't have changed the forecast even if it had been included. The general weather situation was well described by other data from the surrounding area, according to the Weather Service. It was the extremely rapid intensification of the storm that caught the forecasters off guard. It developed when two low-pressure centers converged and formed a new storm that quickly grew to hurricanelike intensity. The storm had a diameter of about 800 miles. On that scale, air-pressure patterns—not winds—are the important factors in forecasting.

Furthermore, the National Weather Service says the buoy in question was 80 percent functional. All of its data were available except for those from the wind sensor, and even that sensor's information usually seemed to be accurate. But because the instrument's readings occasionally shot off the scale, they were withheld.

Local weather forecasters are guided by computer-generated predictions from Washington. These charts, which cover the Northern Hemisphere and even the entire globe, can often anticipate the birth of a storm. But this time the situation developed too fast. Even after recognizing the storm, computers suggested that it would not threaten Georges Bank. Once forcasters realized they had been misled, they posted gale warnings for the area.

All this is less an indication of Weather Service negligence than a lesson in the uncertainties and limitations of weather forecasting. Judge Tauro said that expert testimony from NOAA about the uncertainties "wasn't sufficiently persuasive" to let NOAA off the hook. This may well be an example of a larger problem—of deciding what are essentially technical issues in courts of law. It seems obvious that judges are not really equipped to understand fully the technical explanations of expert witnesses. Certainly, the public should be wary of these limitations.

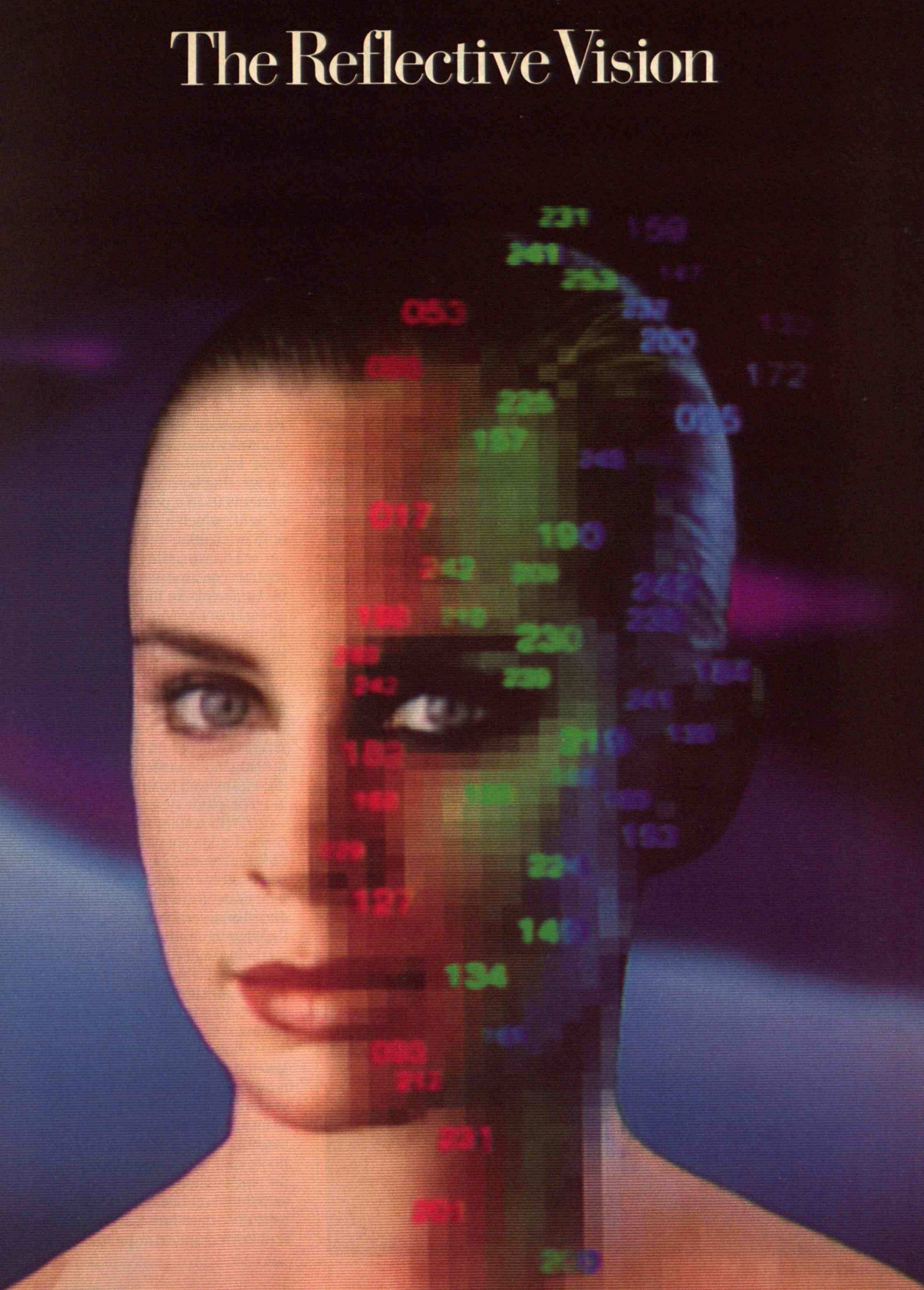
Forecasting skill has improved substantially in recent years, thanks to both more realistic computer modeling and better data gathering, especially with the aid of such "high-tech" tools as satellites and ocean-anchored buoys. Predictions for 48 hours ahead now are as good as 24-hour forecasts were 15 years ago. And medium-range forecasts for three or four days ahead are comparable to the old 48-hour projections.

But making even a 24-hour forecast for a specific area, such as Georges Bank, remains an imperfect art. The product is inevitably based on incomplete data and seasoned with the forecaster's judgment. So it must be used with judgment as well. Perhaps the National Weather Service should not have waited for a routine maintenance trip to repair the suspect anemometer. But it is hard to see how it could have given better weather guidance than it did. Users of weather forecasts must still be prepared for the unexpected—for developments that are too rapid or too localized to be foreseen a day ahead even with today's sophisticated techniques. □

ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*

ILLUSTRATION: ANTHONY RUSSO

The Reflective Vision



The Reflective Vision

A highly advanced design tool developed at the General Motors Research Laboratories uses computers to generate visual images from mathematical data with such accuracy that, soon, in-depth aesthetic evaluations of new concepts may be made prior to creating a costly physical model.

Interactive Display

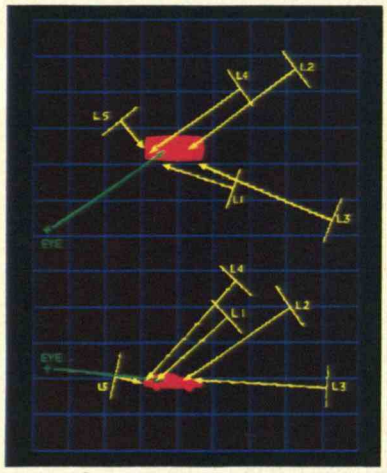
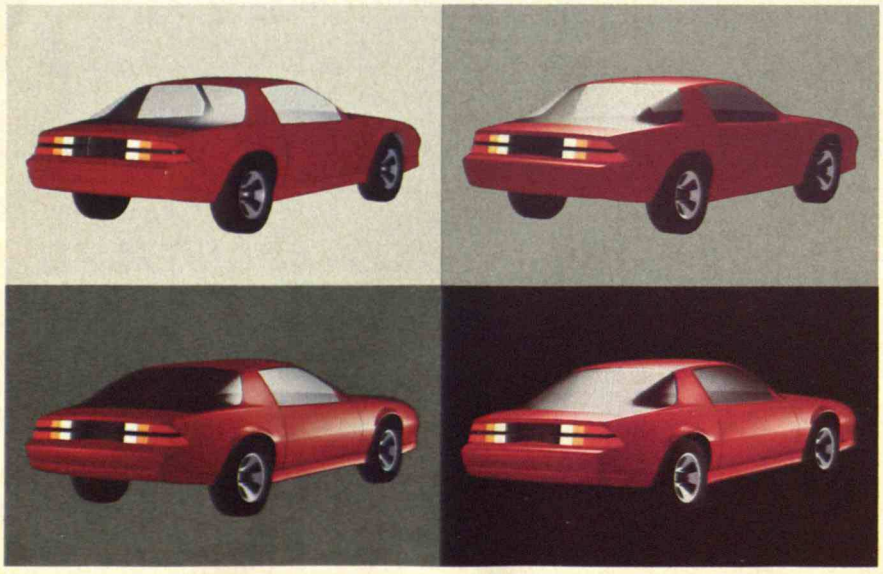


Figure 1: Computer display of plan view (upper) and side elevation (lower), indicating automobile location (red), lighting selections (L1-L5), and viewing position (EYE).

Figure 2: Four Autocolor images, showing the same view of an automobile as background and lighting change.



WITH AUTOCOLOR, users can synthesize three-dimensional, shaded images of design concepts on a color display and then quickly explore how major or minor changes affect the overall aesthetic impression. The system is completely interactive. By choosing from a menu on the screen, the designer can redefine display parameters, select a viewing orientation, or mix a color. Each part of an object can be assigned a surface type with associated color and reflectance properties. Built-in lighting controls generate realistic "highlights" on simulated surfaces composed of differing materials.

Before developing the system, David Warn, a computer scientist at the General Motors Research Laboratories, observed the complex lighting effects achieved in the studio of a professional photographer. By simulating these effects, Autocolor can produce results unattainable by conventional synthetic image display systems. Previous systems used a point source model of light, which allows adjustments only in position and brightness.

The versatility of the lighting controls constitutes a major advance in Autocolor. An unlimited number of light sources can be independently aimed at an object and the light concentration adjusted to simulate spotlight and floodlight effects. The lighting model even includes the large flaps or "barndoors" found on studio lights. These comprehensive controls permit the user to view the simulation in studio lighting conditions, as well as to make revisions in color, paint type, and materials.

With real lights, direction and concentration are produced by reflectors, lenses, and housings. It would be possible to model these components directly, but that would introduce considerable overhead to the lighting computation. Instead of modeling individual causes, Autocolor models the overall effect, reducing complexity by simulating those aspects needed to produce realistic results.

Autocolor approximates the geometric shape of an object with a mesh of three or four-sided polygons. These polygons are grouped to form parts. For a car body, there might be separate parts for the door, hood, roof, fender, and so on. Each part is assigned a surface type, such as painted metal or glass, and each type of surface has associated color and reflectance properties. The

entire data structure is stored in tables using an interactive relational data base developed at the GM Research Laboratories.

THE LIGHTING model determines the intensity of the reflected light that reaches the eye from a given point on the object. It takes into account the reflectance properties of the surface as well as the physics of light reflection. A hidden surface algorithm determines which point on the object is visible at each point on the display. For each of these visible points, the intensity is computed for each light source. The displayed intensity is the sum of the contributions from all the lights plus an ambient term which indicates the general level of illumination.

Using the point source lights of conventional image generation systems, highlighting a particular area of an object can be a difficult task and can result in unwanted highlights in other areas. By contrast, the light direction and concentration controls found in Autocolor make it possible to isolate the effect of a light to a particular area, and achieve a desired highlight easily and quickly (see Figure 2). This is not because Autocolor's lighting model computations are faster, but because its controlled "lights" behave in a more natural way.

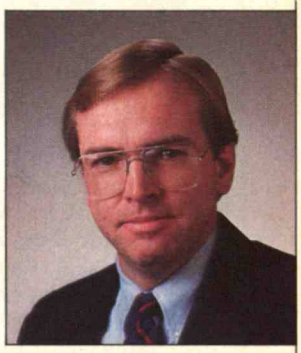
Another unique feature of Autocolor is the ability to portray realistically a variety of different materials and lighting conditions. The color seen from a surface is really a combination of two colors: the color of the surface or material itself (diffuse reflection) and the color of the reflected highlights (specular reflection). The highlight color may be the color of the material, the color of the light, or a color derived from the material and the light.

A different highlight color can be used for each different surface type that is defined. This makes it possible to simulate materials such as plastic, painted metal, and chrome—each of which has different reflectance properties and requires a different highlight color.

The user can interactively adjust the blending of the surface and highlight colors, watching the image change dynamically on the screen until a desired effect is achieved.

"Autocolor will free designers to be more creative," says researcher Warn. "Our goal is to move from controls that show changes in lighting, color, and materials, to software that will let the user change the actual shape, manipulating the image on the screen like a flexible clay model."

THE MAN BEHIND THE WORK



David Warn is a Senior Staff Research Scientist in the Computer Science Department at the General Motors Research Laboratories.

He received his undergraduate degree in mathematics from Carnegie-Mellon University, and his M.S. in computer science from Purdue.

He has done extensive research in relational data management systems with special emphasis on user interfaces and human factors. He also designed the prototype for the network data manager used in the GM Corporate Graphic System. His previous work on other aspects of computer-aided design include system design, file management, and simulation models.

His foremost research interests are in color synthetic image generation and interactive surface design. He joined General Motors in 1968.

Oppenheimer and the Radioactive-Poison Plan

BY BARTON J. BERNSTEIN

"I am become death, the destroyer of worlds." This passage from the sacred Hindu epic *Bhagavad-Gita* flashed into the mind of J. Robert Oppenheimer, director of the Los Alamos A-bomb laboratory, as he viewed the first nuclear explosion in the New Mexico desert on July 16, 1945. Nearby Enrico Fermi, the brilliant Italian-born physicist and Nobel laureate, coolly calculated the power of the weapon by dropping pieces of paper to measure the shock waves.

Within three weeks, the United States had dropped two atomic bombs on Japan, killing at least 110,000 people. In retrospect, many have questioned whether these bombs were necessary to end the war. However, people discussing this question often overlook a crucial issue: our country's use of the A-bomb, aimed largely at civilians in major Japanese cities, was part of a new strategy of killing noncombatants and terrorizing survivors into submission. This practice, developing slowly amid the hatreds of the time, constituted a profound transformation of values: it legitimized the mass killing of civilians as an acceptable form of war.

Despite this new philosophy, the United States did not use gas warfare during World War II. But according to a newly declassified letter from Oppenheimer to Fermi, U.S. scientific advisors did consider the possibility of poisoning half a million of the enemy with radiologically contaminated food. I found the letter that reveals this startling plan in the Library of Congress. Dated May 25, 1943, it illustrates an important fact: amid the horror of World War II, including German concentration camps and the mass killing of Jews, many U.S. scientists, like rank-and-file civilians, were willing to devise new ways to kill the enemy by the thousands and even hundreds of thousands. The evidence suggests that some of these scientists may have had qualms, but they used their intellectual knowhow anyway in developing these weapons of mass death.

The fact that top U.S. scientists seriously considered a plan to radiologically poison the enemy is largely unknown. In fact, neither David Hawkins, who wrote the official history of the Los Alamos laboratory, nor Richard Hewlett, senior author of the official Atomic Energy Commission history of the Manhattan Project, recalls encountering any mention of this proposal. Nor do any of the 16 Manhattan Project scientists whom I queried—including Hans Bethe, Edward Teller, Robert R. Wilson, Emilio Segrè, Robert Serber, Frank Oppenheimer, Philip Morrison, Eugene Wigner, and Richard Feynman—remember hearing about this plan during or after the war. Most were shocked when they recently saw the declassified document.

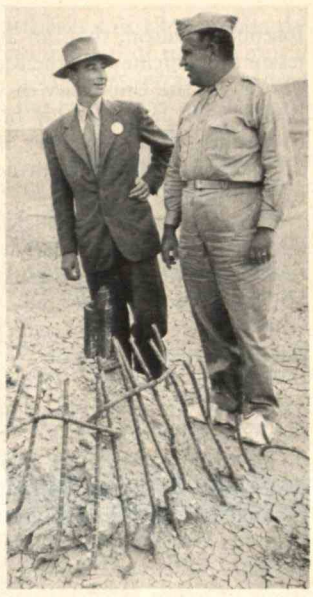
BARTON J. BERNSTEIN is professor of history at Stanford University specializing in foreign policy, the arms race, and science and technology policy. His last article for Technology Review, *"The Misguided Quest for the Artificial Heart," appeared in the November/December issue.*

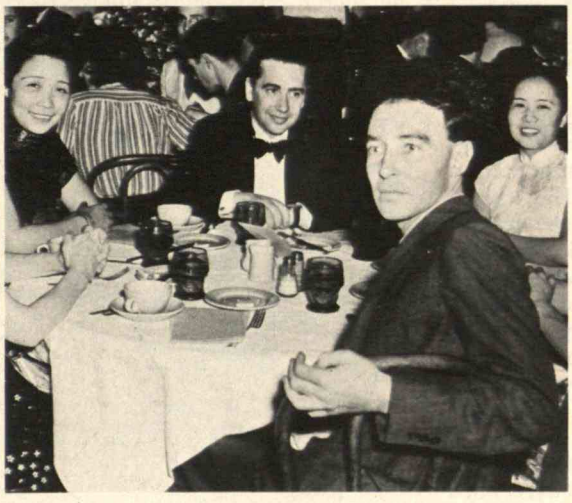
A Tempting Thought

Most of these scientists have forgotten, or never knew, that in 1941 a scientific advisory committee to the National Academy of Sciences suggested that the United States develop the radioactive products of fission as weapons. This committee, chaired by Arthur Holly Compton, a Nobel laureate in physics, gave the quest for such weapons a higher priority than the atomic bomb. But the growing feasibility of the atomic bomb soon overshadowed this effort.

However, in 1943, Gen. George C. Marshall, army chief of staff, Gen. Leslie Groves, commanding general of the Manhattan Project, and James Conant and Vannevar Bush, scientific advisors to President Roosevelt, feared that Germany might develop and use radioactive byproducts as weapons in Europe. Vague fears of such an attack spurred attention

A recently declassified letter shows that top U.S. scientists considered a plan to mass-poison the enemy during World War II.





J. Robert Oppenheimer (far left) was party to the top-secret plan to poison half a million of the enemy with fission byproducts. The scheme may have been the brainchild of Enrico Fermi, shown (top left) with Oppenheimer in 1946. Gen. Leslie Groves (shown above with Oppenheimer) was afraid the Germans would also develop fission products as weapons. Most scientists were unaware of the food-poisoning plan. Emilio Segrè, Fermi's biographer, shown at a banquet (left) with Oppenheimer in 1939, was baffled at Fermi's central role in the scheme.

to the need for possible defensive measures during the 1944 D-Day invasion. And as the Oppenheimer letter reveals, this concern also apparently spilled over into tempting thoughts about the United States' developing some kind of radioactive poison.

Success with the A-bomb was still uncertain at the time, and Fermi may have been pushing the idea of a poison because it would require smaller amounts of critical material and therefore could be developed sooner. After all, if Americans were building a bomb for use against a hated enemy, why should the use of radioactive poison create profoundly new moral issues?

In the 1943 letter to Fermi, Oppenheimer counseled delay in pursuing the plan and proposed as a criterion "poison[ing] food sufficient to kill a half-million men, since there is no doubt that the actual number affected will, because of non-uniform distribution, be much smaller than this." (Oppenheimer's conception of who the ultimate human targets would be—whether noncombatants, troops, or both—remains unclear.)

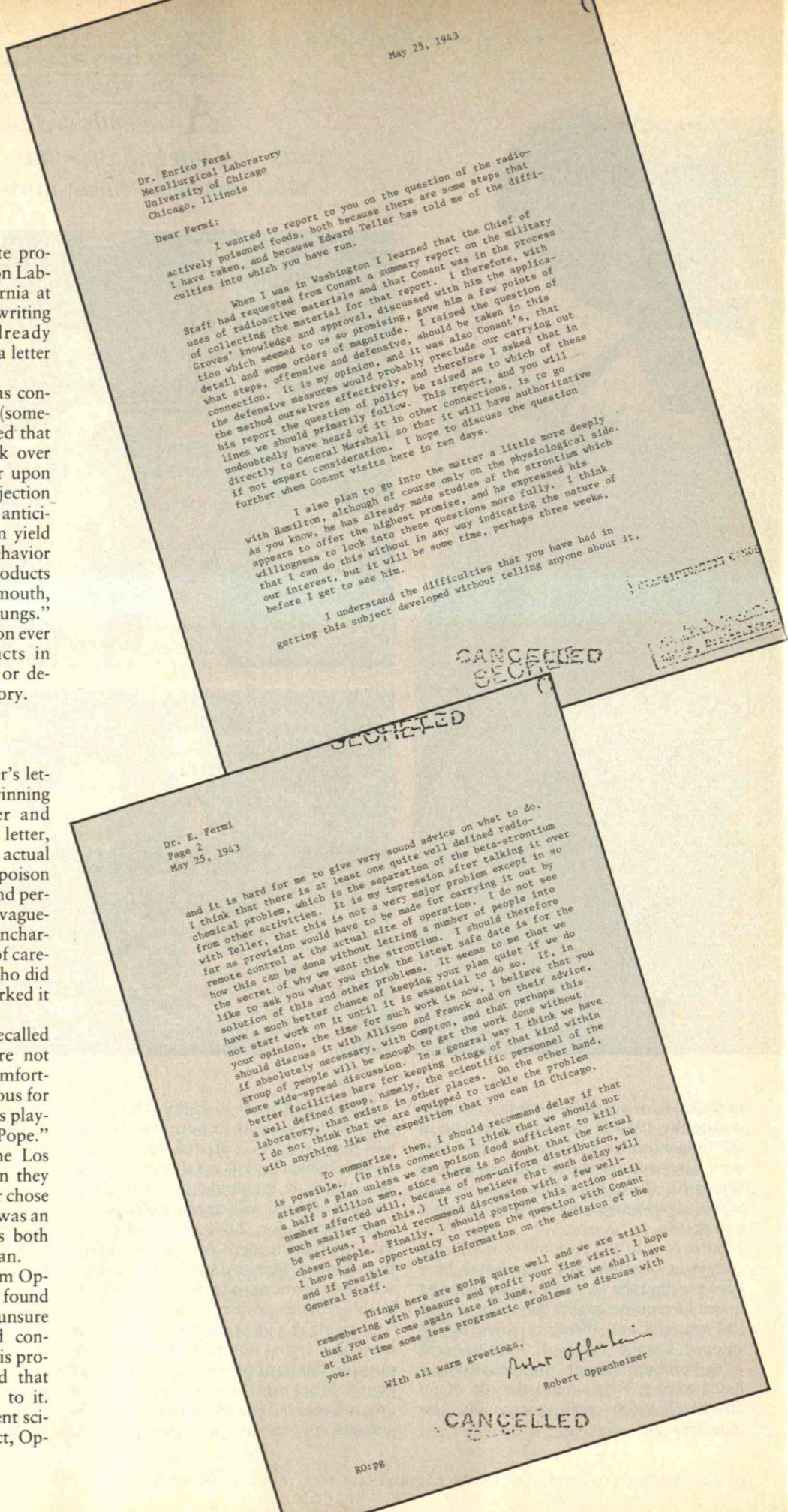
In giving this advice, Oppenheimer may have been trying to establish a nearly impossible standard of lethality as a way of gently blocking the plan on technical grounds without directly raising moral objections. Or, to suggest a less charitable interpretation, he may have lacked, or already overridden, personal doubts about the ethics of mass killings; he may have been troubled only by technical matters of efficacy and access to resources.

In briefly discussing the purification of beta-strontium and stressing secrecy, Oppenheimer seemed sincerely interested in—even supportive of—the proposal. "It seems to me," he wrote Fermi, "that we have a much better chance of keeping your plan quiet if we do not start work until it is essential to do so." However, he also could have been using the need for secrecy to justify delay.

Oppenheimer promised to discuss the medical aspects of the plan with physician

PHOTOS: UNIVERSITY OF CALIFORNIA LAWRENCE BERKELEY LAB; UPI/BETTMANN NEWSPHOTOS

Recently unearthed in the Library of Congress, the letter about the mass-poison plan (shown here in facsimile) was written by J. Robert Oppenheimer to Enrico Fermi, also working on the project.



May 25, 1943

Dr. Enrico Fermi
Metallurgical Laboratory
University of Chicago
Chicago, Illinois

Dear Fermi:

I wanted to report to you on the question of the radioactively poisoned foods, both because there are some steps that I have taken, and because Edward Teller has told me of the difficulties into which you have run.

When I was in Washington I learned that the Chief of Staff had requested from Conant a summary report on the military uses of radioactive materials and that Conant was in the process of collecting the material for that report. I therefore, with Groves' knowledge and approval, discussed with him the application which seemed to us so promising, gave him a few points of detail and some orders of magnitude. I raised the question of what steps, offensive and defensive, should be taken in this connection. It is my opinion, and it was also Conant's, that the defensive measures would probably preclude our carrying out the method ourselves effectively, and therefore I asked that in his report the question of policy be raised as to which of these lines we should primarily follow. This report, and you will undoubtedly have heard of it in other connections, and you will directly to General Marshall so that it will have authoritative if not expert consideration. I hope to discuss the question further when Conant visits here in ten days.

I also plan to go into the matter a little more deeply with Hamilton, although of course only on the physiological side. As you know, he has already made studies of the strontium which appears to offer the highest promise, and he expressed his willingness to look into these questions more fully. I think that I can do this without in any way indicating the nature of our interest, but it will be some time, perhaps three weeks, before I get to see him.

I understand the difficulties that you have had in getting this subject developed without telling anyone about it,

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Dr. E. Fermi
Page 2
May 25, 1943

and it is hard for me to give very sound advice on what to do. I think that there is at least one quite well defined radiochemical problem, which is the separation of the beta-strontium from other activities. It is my impression after talking it over with Teller, that this is not a very major problem except in so far as provision would have to be made for carrying it out by remote control at the actual site of operation. I do not see how this can be done without letting a number of people into the secret of why we want the strontium. I should therefore like to ask you what you think the latest safe date is for the solution of this and other problems. It seems to me that we have a much better chance of keeping your plan quiet if we do not start work on it until it is essential to do so. If, in your opinion, the time for such work is now, I believe that you should discuss it with Allison and Franck and on their advice, if absolutely necessary, with Compton, and that perhaps this group of people will be enough to get the work done without more wide-spread discussion. In a general way I think we have better facilities here for keeping things of that kind within a well defined group, namely, the scientific personnel of the laboratory, than exists in other places. On the other hand, I do not think that we are equipped to tackle the problem with anything like the expedition that you can in Chicago.

To summarize, then, I should recommend delay if that is possible. (In this connection I think that we should not attempt a plan unless we can poison food sufficient to kill a half a million men, since there is no doubt that the actual number affected will, because of non-uniform distribution, be much smaller than this.) If you believe that the actual be serious, I should recommend discussion with a few well-chosen people. Finally, I should postpone this action until I have had an opportunity to reopen the question with Conant and if possible to obtain information on the decision of the General Staff.

Things here are going quite well and we are still remembering with pleasure and profit your fine visit. I hope that you can come again late in June, and that we shall have at that time some less programatic problems to discuss with you.

With all warm greetings,

Robert Oppenheimer

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RO:pg

Joseph Hamilton, then an associate professor of medicine with the Radiation Laboratory at the University of California at Berkeley. In fact, the day before writing to Fermi, Oppenheimer had already obliquely mentioned the project in a letter to Hamilton.

A week later, Hamilton, who was conducting radiological experiments (sometimes on unknowing people), replied that he was "extremely anxious to talk over with you the questions which bear upon the problems of infection by (or injection of) fission products." Hamilton anticipated that his research would soon yield important information on "the behavior of the principal long-life fission products when introduced into the body by mouth, by injection, and directly into the lungs." Whether Oppenheimer and Hamilton ever actually discussed fission products in terms of either offensive weapons or defensive measures seems lost to history.

The Barbarities of Total Warfare

When recently shown Oppenheimer's letter, Emilio Segrè, a Nobel Prize-winning physicist and Fermi's biographer and friend, was frankly puzzled. The letter, Segrè emphasized, left unclear the actual physics of producing a radiological poison and the tactics for poisoning food and persuading the enemy to eat it. Such vagueness, Segrè stressed, was very uncharacteristic of Fermi; he was the kind of careful, deliberate, thorough scientist who did not propose a plan until he had worked it out fully.

Some Los Alamos alumni have recalled that Oppenheimer and Fermi were not close—that Oppenheimer felt uncomfortable with the physicist who, so famous for the infallibility of his judgments, was playfully but respectfully called "the Pope." Once, during a game in which the Los Alamos scientists named the person they would most like to be, Oppenheimer chose Fermi—who, unlike Oppenheimer, was an unambivalent man and brilliant as both an experimentalist and a theoretician.

Former friends and associates from Oppenheimer's Los Alamos years also found the 1943 letter puzzling; most were unsure of his intentions. One old friend concluded, "I get the impression that this proposal was initiated by Fermi, and that Oppenheimer was rather opposed to it. But since Fermi was the most eminent scientist in the entire Manhattan Project, Op-

penheimer took his proposal rather seriously."

Another distinguished physicist friend speculated that Oppenheimer may have feared opposing the plan openly because his earlier left-wing affiliations had made it difficult to obtain a security clearance, and he did not want to jeopardize the Los Alamos project. This scientist suggested, "I cannot understand this in any way except that [Oppenheimer] was establishing himself as an important person in Washington—or that he actually approved (in those desperate times) of the possibility. I will not judge Oppy in these respects without knowing more about what was really involved. Oppy was a different person at different times, and perhaps . . . at different places."

Frank Oppenheimer, the younger brother of Robert and himself a physicist, called the letter "bloodthirsty." "In those days we talked about everything, any way of killing," he remarked, putting the letter in the perspective of Americans waging brutal war against hated enemies.

Physicist Robert Serber, a former Oppenheimer student, recalls that as early as 1942, scientists working on the Manhattan Project discussed the use of fission products—even of contaminating an area by dropping radioactive material from a plane. Another former Oppenheimer student recalls "various conversations about it [the radioactive poison scheme], not with JRO [J. Robert Oppenheimer], but more casually. It always seemed a bad idea, like the related one of poison gas and the still less acceptable one of crop poisons, especially potato blight. All those various barbarities were in the stream of military novelty."

Unanswered Questions

The fate of the "radioactively poisoned food" idea remains unclear. On June 17, 1943, presumably in reply to Oppenheimer's letter, Fermi wrote to him at Los Alamos, "I have been thinking considerably on the point, and I believe that if anything at all should be done on those lines, some work should be started in the very near future. I hope to have an opportunity to discuss this matter with you on my next visit."

In the end, the project probably foundered on substantial technical problems and the reluctance of top military personnel to divert resources from the A-bomb. In November 1943, Vannevar Bush noted in a secret memo to Gen. Groves "the problems of handling large amounts of [fission] material in a single package . . . due to the heat generated . . . and the problem of dissipation."

Two years after Oppenheimer discussed radiological poisoning with Fermi, the vast majority of Americans enthusiastically welcomed the atomic bombings of Japan. Yet both during and after the war, the U.S. public seemed to retain a repugnance for gas warfare, according to surveys at the time. Would Americans have viewed radioactive poisoning of hundreds of thousands of people, including civilians, as a new barbarism or a legitimate form of total war? Would it have made a difference if the target had been Germany rather than Japan? These troubling questions are impossible to answer in retrospect.

Expressing a queasiness about the A-bomb project, Isidor Rabi, a Nobel-laureate physicist, asked in 1943: "Was this to be 'the culmination' of three centuries of physics?" Two years later, he warned, "If we take the stand that our object is merely to see that the next war is bigger and better, we [scientists] will ultimately lose the respect of the public. In popular demagogy we [will] become the unpaid servants of the 'munitions makers' and mere technicians rather than self-sacrificing public-spirited citizens which we feel ourselves to be."

Looking back four decades later on Fermi's proposal and Oppenheimer's lack of explicit moral opposition to it, another distinguished physicist who first knew Oppenheimer in the postwar years at Princeton concluded that it "is a magnificent example of military madness being encouraged by learned professors."

Others, more charitably, might say that it was just another venture—albeit one not substantially pursued—in the virtually total hostilities of World War II.

History of Hackers, and Toward Total Automation

Computer Revolutionaries

Hackers: Heroes of the Computer Revolution
by Steven Levy
Doubleday, $17.95

Reviewed by Frank Morgan

When young Peter Deutsch first glimpsed the world of computers through a discarded users' manual, he felt "the same kind of eerily transcendent recognition that an artist experiences when he discovers the medium that is absolutely right for him. *This is where I belong.*" When Peter Samson discovered computers, it was as if he "opened the door and walked though this grand new universe." The first few adventurers to peer into this uncharted universe in the late 1950s yearned to explore it and tame it. "My big thing is discovery," said Mark Duchaineau, who loved to spend long hours just trying to see what his Apple could do. He hit upon an ingenious and important method for loading information into the computer from a disc in one-twentieth the time previously required to do so.

Steven Levy's *Hackers* conveys a real understanding and affection for these innovators who saw the possibilities, the creative order, the beauty of computers and largely created the technology we know today. Levy sensitively centers his book on the personal experiences and attitudes of over a hundred participants from the early computer days at M.I.T. to the modern era of Silicon Valley software.

As you get to know these revolutionaries, you want to befriend them for their striking combination of brilliance and inadequacy. The genius of computer-game writer John Harris springs from a deep, innocent love for computer games ("it's just me, I guess") from which success and wealth come unsought. His inadequacy wells up when, on a rare date, the shy young man locks his keys in his new four-wheel-drive vehicle and then gets stuck in the snow. The contrast between the two traits is especially vivid when, after months of virtuoso programming (at one point he sits down to work and soon discovers to his surprise that it is the following day), he loses all his tapes at a convention.

For all their shyness and innocence, the computer prodigies did what they believed in before *People* magazine ever took an interest in their field. These pioneers chose computers over school, friends and recreation regardless of outside pressures—rare individuals in our faddist age of the *Today* program and disco dancing.

But despite Levy's sympathetic portrayal, it is hard to identify with these unorthodox hackers or wholly to admire them. Many seem self-indulgent rather than noble, held more by the pleasure, power, and familiarity of computers than by any deliberate purpose. Certainly John Harris did not bother with budgeting time and planning for a desired outcome: "Whatever my mind is doing, I just let it flow." Many hackers seemed to enjoy perpetually making and correcting mistakes.

I remember one time during my own freshman year at M.I.T. when my roommate and other students were given a computer assignment. For about a week, everyone submitted programs each night. The students labored endlessly to track down errors ranging from faulty reasoning to omitted commas in a desperate effort to get their programs to work.

Except my roommate. He did not get around to the assignment until the last day, but he was *careful*. And on its first trial, his program ran perfectly. That was intelligence. (Of course, it would have been better to do it the *first* day.)

Another year, when I was a visiting professor at Rice University, terminals for use by students were installed not in a computer center but right in the middle of the Mathematics Department, on the same hallway as my office. Some evenings I had to tiptoe gingerly through a corridor littered with the lounging bodies of waiting students, half-eaten snacks, and the sadly neglected homework from my own sophomore calculus course. The next morning I would return to find some of the same students, half-eaten snacks, and unattended homework. I began to suspect that these students preferred spending the night in the corridor to doing their calculus problems and sleeping. Programming is appealing because success seems only moments away, while reasonable calculus problems often look impenetrable at first.

Bohemian habits, colorful characters, and a new subculture provide an author like Levy with plenty of humorous material, and he makes the most of it. He tells of the time that the "gleeful, bald-headed" Marvin Minsky, head of the Artificial Intelligence Laboratory at M.I.T., was suddenly attacked by a table-tennis robot who, "seeing the glare reflecting from Minsky's bald dome, mistook the professor for a large Ping-Pong ball."

Levy also describes how Peter Samson terrified an oppressively bureaucratic computer "sub-priest" (assistant supervisor) by pretending that a horribly smashed module from an electronic junk shop was part of the sacred IBM computer: "Samson, who had wide green eyes that could easily look maniacal, slowly pointed to an open space on the machine rack, where, of course, no board had ever been, but the space still looked sadly bare. The sub-priest gasped . . ."

Indeed, Levy so completely captures the world of computer prodigies that he seems to become part of it himself. While he masterfully conveys their spirit, he sometimes slips into their self-indulgence and tiresome cuteness. He fondles the word "hacker" so much that it loses the meaning he has struggled to give it—someone purely dedicated to making a system work perfectly—and assumes the cloying banality of an old television commercial.

But he does provide striking insights into the nature of problem solving. He describes brilliance as "approaching the problem from an offbeat angle that no one had ever thought of before but that in retrospect made perfect sense . . . a genius-from-Mars technique."

This definition reminds me of a little problem I ran across last month: How many of the 1,000 numbers from 000 to 999 contain the digit 9 at least once? We

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know that 100 of them, from 900 to 999, start with a 9. Similarly, 100 have a 9 in the middle, and 100 end with a 9. But now we have counted numbers with two 9s such as 939 twice, and 999 three times, and the solution is getting complicated.

A more ingenious approach is to turn the question around and ask how many of the numbers *do not* contain the digit 9. There are 9 choices for the first digit (0,1,2,3,4,5,6,7,8) multiplied by 9 choices for the second digit, multiplied by 9 choices for the third digit. This yields 729 numbers without the digit 9, or 271 numbers with the digit 9 (1,000 minus 729). The more creative solution is simple.

Levy does not make the mistake of defining in detail the formidable historic problems of developing computers. But in describing the magnitude of their appeal and the brilliance of their conquerors, he manages to convey the joy that comes with finding perfect solutions to seemingly impossible problems. □

FRANK MORGAN is Cecil and Ida Green Career Development Professor of mathematics at M.I.T.

In Pursuit of Total Automation

Forces of Production
by David F. Noble
Knopf, $22.95

Reviewed by Jonathan Schlefer

Since the nineteenth century, not only advocates of capitalism but critics such as Marx have been awed by its capacity to exploit new technology and boost productivity. Each generation has turned out a plethora of goods that its predecessors could not have imagined. Of course, capitalism has always had its crises and depressions, and the U.S. government has tried to even out the cycles with institutional changes—by creating the Federal Reserve system in the early twentieth century and, beginning with the New Deal, by using taxes and spending to regulate demand. However, during the slumps of the seventies, Americans began to focus on the very workings of the economic machinery: managerial failures during that period to continue using technological innovation to boost productivity.

Where has the chain of innovation and productivity come unlinked? One theory holds that U.S. managers prefer to reap short-term profits rather than perform the patient work of improving products and attending to the shop floor. But can mere misguidedness explain systematic failures? Some critics charge that managers care more about solidifying their own power than increasing productivity. I have even heard industry engineers claim that power struggles between management and labor, rather than any attempt to increase productivity, have dominated the introduction of automation.

This is the case argued by David F. Noble, curator of industrial automation at the Smithsonian Institution and formerly a controversial M.I.T. faculty member, in *Forces of Production*. Noble applies his argument to one industry, during one era, in one country. His story begins in the U.S. during the anticommunist hysteria of the fifties, when the labor movement, seeking to avoid being branded un-American, severed any socialist connections and became the loyal opposition to business. U.S. unions bargained over wages and benefits but, unlike their European counterparts, acquiesced on management issues such as the introduction of new technologies. Meanwhile the U.S. military—a powerful institution with no true European equivalent—sought to marshal advanced technology to counter the communist threat abroad. Specifically, the air force promoted automated machine tools

One form of automation gave more control to machinists, the other to management.

to cut aerospace parts with extreme precision from hard alloys.

Machine tools—drills, lathes, and milling machines—have been basic metal-cutting equipment since the nineteenth century. They are used to fashion the dies on which to stamp automobile fenders; they shape parts for the machines that insert rivets to hold together items ranging from aluminum canoes to desk hinges. Machine tools cut huge ship propellers and blades for steam turbines. Running these tools has traditionally been a skilled job. With dirty hands and great care, some white-haired, bespectacled machinist would calculate angles, adjust cranks, and run cutting bits to shape metal to make the machinery of mass production.

Managers could not control the output of these skilled workers by varying the speed of the assembly line, and machinists' unions were often militant: if they walked off the job, scabs could not fill in. Noble argues that the military, academic engineers, and corporate managers tried to subdue this lingering center of labor turbulence through the method they used to automate machine tools.

Noble's argument is based on the fact that two forms of automation were available: one gave more control to machinists, the other to management. In "record playback," developed by General Electric, a machinist cut a part while a tape recorder registered the machine's motions. The tape was then played back to make the machine cut more parts. In the early fifties, John Diebold of Harvard Business School (now of the Diebold Group) maintained that record playback was simple enough to be used even by a small job shop.

The other approach was numerical control (NC), developed by M.I.T. engineers under contract to the air force. A mathematician programmed a computer to punch a tape, which ran the machine tool much like a player piano. In the days of M.I.T.'s Whirlwind computer—it would be compared to molasses in January these days—writing the program to punch the tape could take a PhD several weeks, says Noble. In contrast, a machinist could create a tape for a record-playback machine in a few hours.

Numerical control was good for machining precision aerospace parts for which cost was no object. Record playback fell by the wayside as air force contracts began requiring NC, industry leaders adopted it, and trade journals touted this automation run by white-collar programmers. "TOTAL COMMAND," boasts an advertisement quoted by Noble. "Why not? Install a terminal in your office, and you can control [the NC tool] yourself. . . . The operator simply loads and unloads."

Despite the promoters' vision of total automation, NC remained so complex and costly for civilian industries that only 0.5 percent of U.S. machine tools used it by 1968, and just 2 percent by 1978. Only

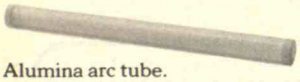
Continued on page 75

The search for a

Summary:

GTE scientists are turning out a growing spectrum of structural ceramic products with predictable lifetimes. Among these are metal-cutting tools, turbine-engine components, radomes, and arc tubes for high-energy discharge lamps. Disciplines go beyond ceramics to include physics, chemistry and metallurgy.

GTE research is pushing back the technical barriers to the use of ceramics in high-stress environments. Reliable products of such materials as silicon nitride, yttria toughened with lanthana, alumina and composites are helping disprove the old belief that "ceramics" implies strength or toughness reliability problems.

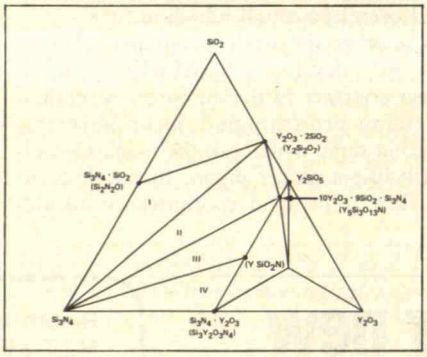


Alumina arc tube.

Today, we are producing ceramics with strengths over 100,000 psi at 1100°C. Ceramics that are transparent to electromagnetic radiation. Ceramics with high fracture toughness, low flaw content, oxidation resistance and high-temperature stability.

The "metallurgy" of ceramics.

Many of these products ring like metal. Coincidental or not, developing them involves protocols traditional to metallurgical research.



Typical phase diagram for silicon nitride with rare earth additives.

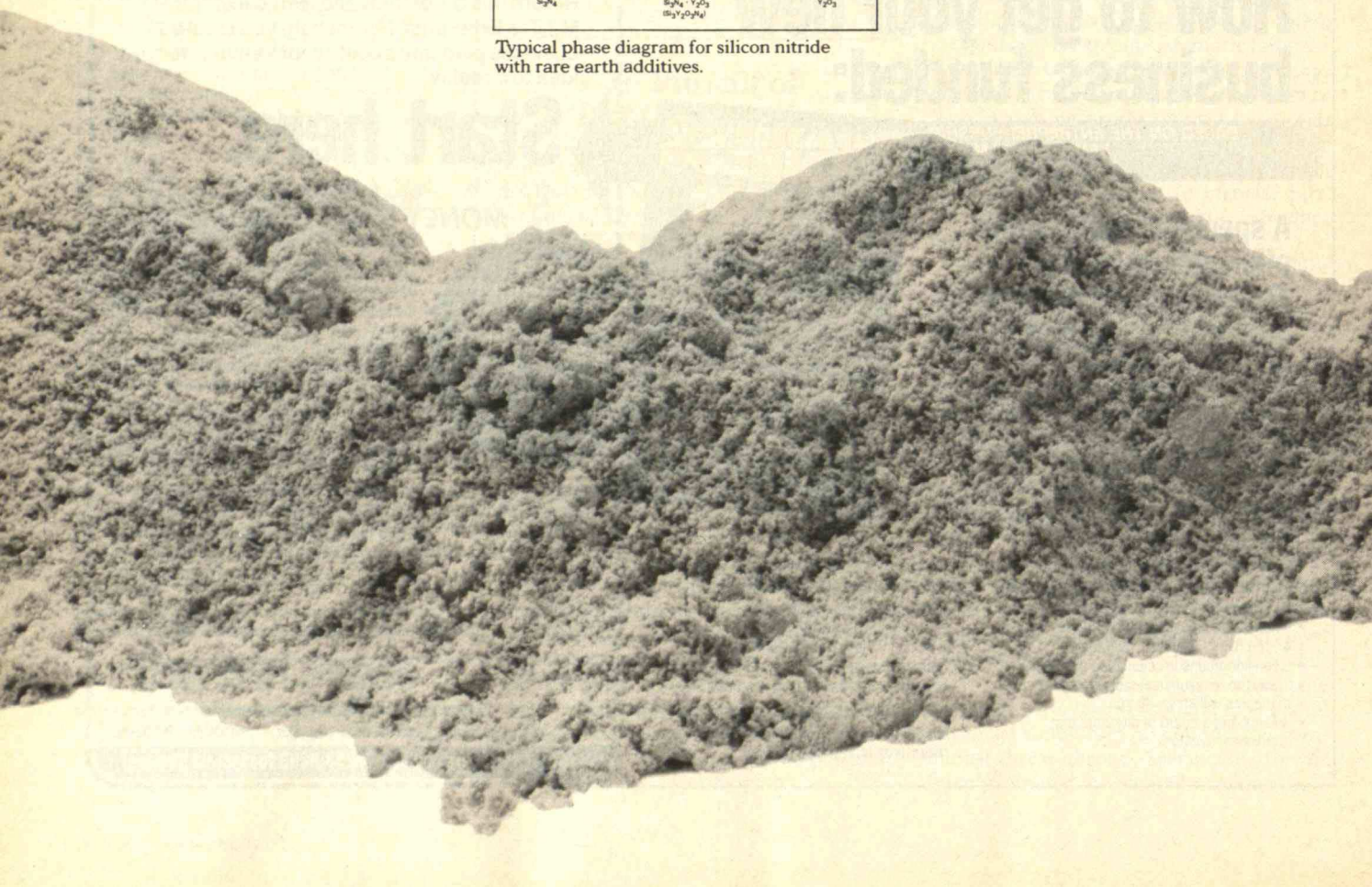
Radome of silicon nitride.

It begins with phase diagrams, and empirical studies of compositions within each phase. Research into phase composition and microstructure control leads to predictable physical and mechanical properties—verified with Weibull statistics.

Research even helps us learn how to join structural ceramics to their support materials.

The materials.

At GTE, high-technology ceramic components begin as powders under precise control of submicron size, shape and purity. Consolidation procedures have been worked out to achieve the reliability inherent in



flawless ceramic.

these powders. Again, the similarity to metals is apparent.

In metals, average properties tend to cluster in a rather tight locus. This had not been true of ceramics until recently. But now, GTE is able to consolidate ceramics with uniform microstructure, and with Weibull statistics in the range of superalloys.

Silicon nitride matrix composite cutting tools.

Grain-boundary science.

As with powder metallurgy, parts are molded and sintered. This demands special knowledge of densification additives to help create precision-molded net shapes, and provide the necessary strength in the grain-boundary phase.

GTE has developed families of additives to provide optimized properties for specific products.

Reliable "crockery"?

GTE research is pushing back the technical barriers to the use of ceramics in high-stress environments.

Ceramic matrix composites toughened with discrete particles or fibers are one thrust of the GTE search for more reliable ceramics.

Fully effective, predictable structural components are already proving to be practical in a fast-growing array of applications.

More materials science.

Materials research moves ahead in other areas at GTE, too. High-purity GaAs crystals for semiconductors; amorphous metals for brazing foils; better phosphors for ultraviolet radiation conversion—these are among the many activities currently underway at GTE.

In the box at the right is a list of some pertinent papers GTE people have published relating to research in advanced ceramics. For any of these, you are invited to write GTE Marketing Services Center, Department TP-M, 70 Empire Drive, West Seneca, NY 14224. Or call 1-800-828-7280 (in N.Y. State 1-800-462-1075).

Pertinent Papers

Phase Effects in Silicon Nitride Containing Y_2O_3 or CeO_2: Part I—Strength; Part II—Oxidation. J. American Ceramic Soc., May, 1980.

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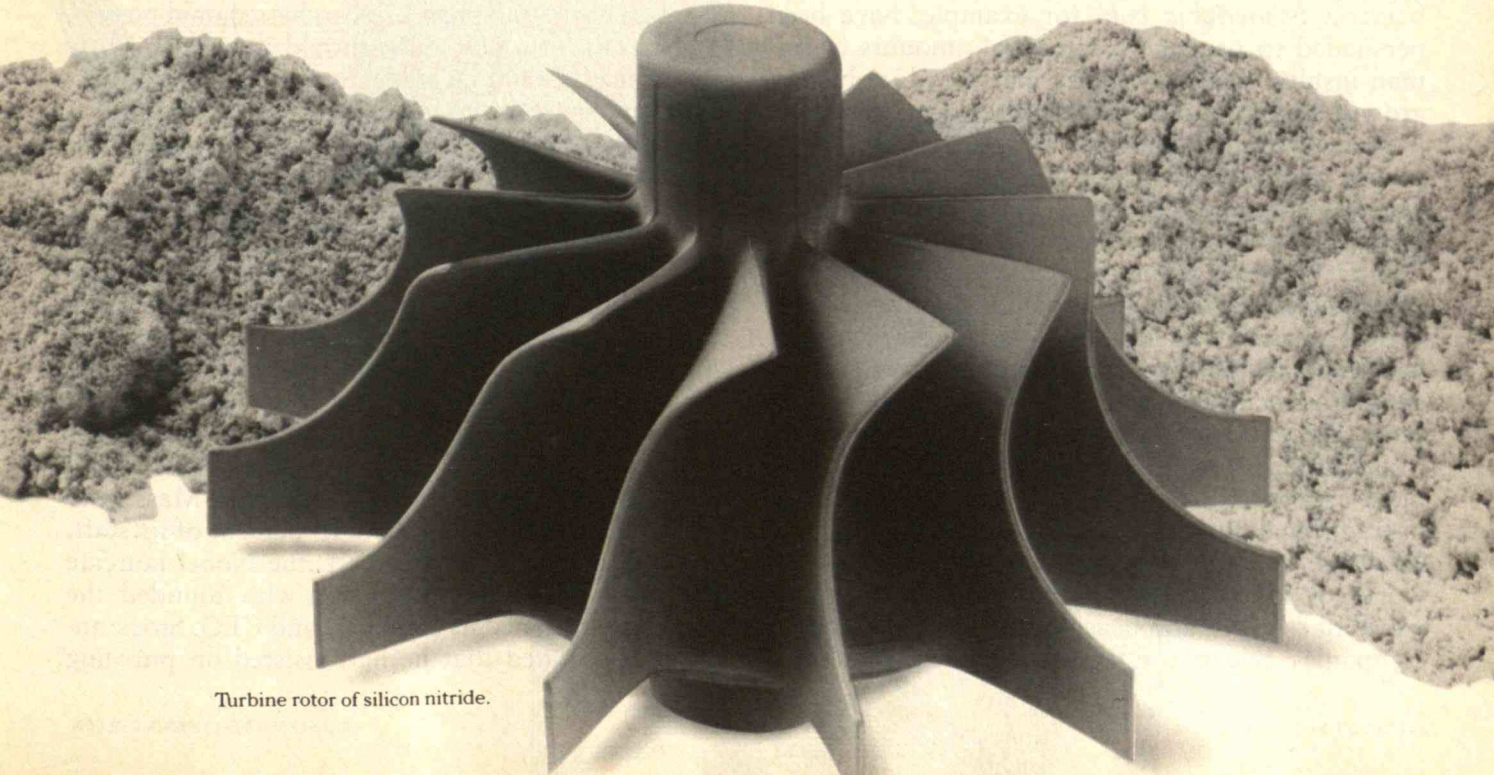
GTE



Turbine rotor of silicon nitride.

The Culture Chasm: Scientists and Managers in Genetic-Engineering Firms

BY FRANK A. DUBINSKAS

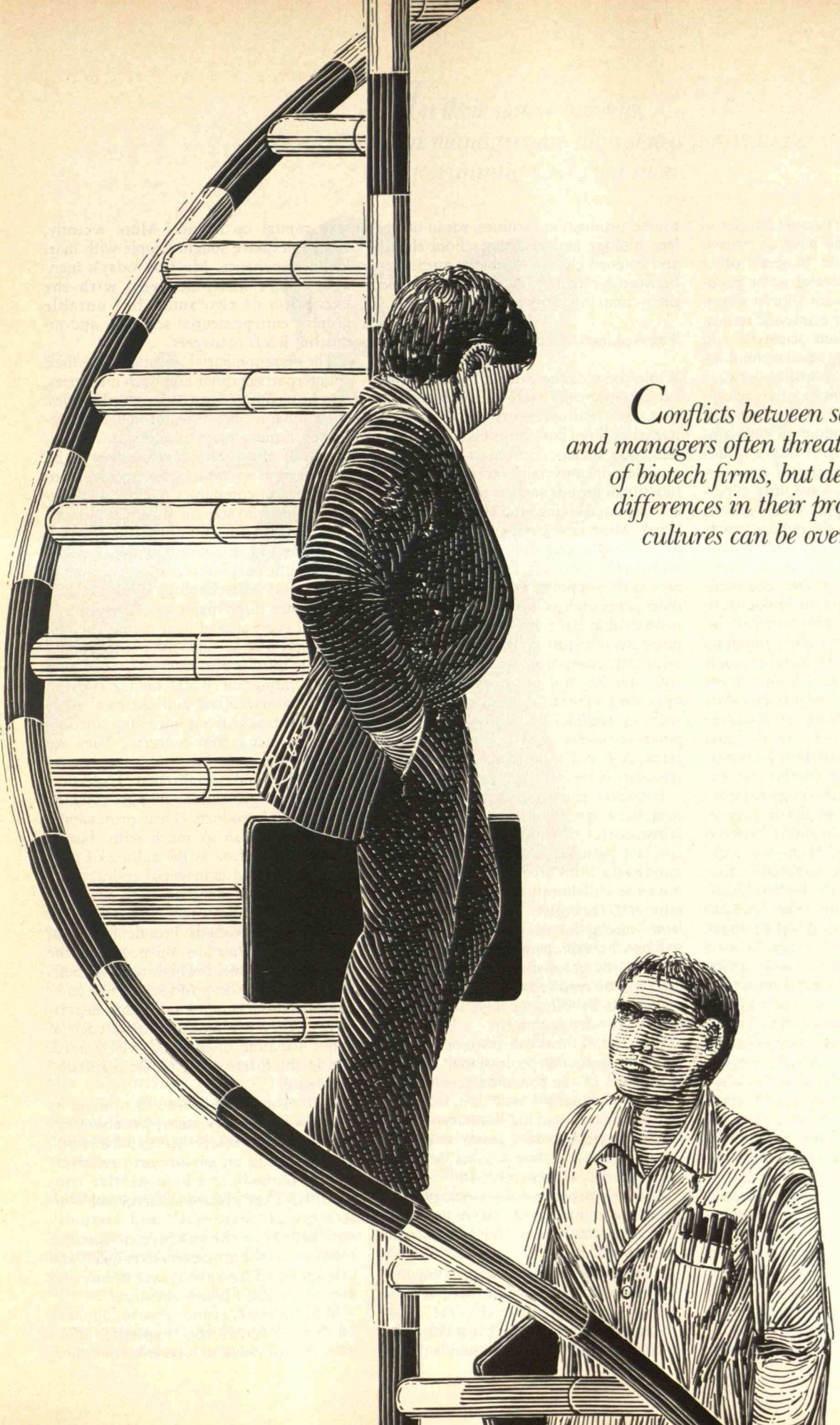
One of the most conspicuous events in the business world of the 1980s has been the emergence of small entrepreneurial companies that sell the research results and products of genetic engineering. The companies use techniques pioneered by university researchers who have discovered how to clip individual genes from one organism and insert them—in full working order—into a completely different organism. The common gut bacteria *Escherichia coli*, for example, have been persuaded to produce commercial amounts of human insulin. Similar bacteria mass-produce human growth hormone, a substance previously available in severely limited amounts. Today about 200 companies, most founded near Boston, San Francisco, and Washington, D.C., since 1980, are at work on genetically engineered products.

What is unique about these companies is their mix of personnel. Emerging companies in older technological areas such as aerospace and microelectronics have generally groomed their managers on the inside, promoting scientists and engineers to management posts. By contrast, the new biotechnology firms have a high proportion of non-scientists as managers. The main expertise of these managers, who are trained in traditional business schools such as Stanford and Harvard, is in dealing with the outside financial world of investors rather than with the internal world of research and development. In addition, the companies' scientific staffs are recruited fresh from academic labs. Unlike scientists in, say, microelectronics firms, they have no industrial experience.

Because of these differences, start-up biotechnology companies often show two public faces—one of academic science, and the other of financial entrepreneurship. And like the Janus of Roman mythology, the two faces frequently look in opposite directions. The practical outcome is intramural conflict. Bench scientists and executives clash over what goals the company's researchers should pursue, whether the firm's direction should change, and how the choices should be made. Such conflicts can portend problems for either the short-term products that guarantee cash flow or the long-term research projects that offer hope for a future big success.

Three years ago, for example, the management of Cetus Corp. in Emoryville, Calif., suddenly terminated its "new ventures group," which pursued more open-ended research. The company dismissed more than 30 scientists and caused severe distress and much reshuffling of tasks in its labs. Last December, cash-strapped Genex Corp. of Rockville, Md., cut 16 percent of its staff to "streamline the company's administrative and research departments." One month before, Biogen, Inc. of Cambridge, Mass., and Geneva, Switzerland, laid off 13 percent of its staff. Soon after that Walter Gilbert, the Nobel laureate and former Harvard professor who founded the company, resigned as chairman and CEO. Stock analysts speculated that he had insisted on pursuing

ILLUSTRATIONS: CHRISTOPHER BING



Conflicts between scientists and managers often threaten the success of biotech firms, but deep-rooted differences in their professional cultures can be overcome.

"big ticket" research on gamma interferon and interleukin-2, which have no proven therapeutic value, while Biogen's other managers wanted to develop safer products, like diagnostics, with shorter development times and faster economic return.

Disagreements between scientists and executives occur in many small technology companies. But the relationship between biologists and managers is often exceptionally strained because of the nature of biotechnology. The production problems of scaling up processes from the petri dish to the thousand-liter fermentor are vast, and academic scientists have little experience with them. Many potential products, especially pharmaceuticals, require nearly a decade from discovery in the laboratory to a salable product out the door. That's a long time to wait for profits, and managers continually pressure the biologists to speed up their work. This urgency increases three or four years after founding, when executives must seek further rounds of financing. Entrepreneurs must present compelling accounts to outside investors of their successes, or at least potential successes—and the scientists' work must somehow form the basis of these accounts.

The opportunities for conflict are exacerbated in most biotechnology firms by a consistent segregation of physical space, functions, and communications between managers and scientists. Firms are organized into two separate hierarchies that rarely interact except at the highest levels.

Even at these levels, biologists and executives complain of misunderstandings by the other group. Both recognize that managerial and scientific decisions are intertwined. Yet the firms are rife with tales of sudden layoffs and project curtailments like those at Biogen, Genex, and Cetus.

There are, I believe, underlying reasons for this situation. Managers and biologists inhabit quite different cultures: the ways in which they interpret the world, communicate, and interact vary considerably. In particular, the two groups take entirely disparate views of time regarding both completion of specific work projects and development of their professional careers. In those cultural differences lie the seeds of dissension.

As an anthropologist, I have spent two years observing the interactions between scientists and managers in more than 20 start-up biotechnology companies. I pored over literature about the companies, interviewed managerial and scientific staffs, toured production facilities, sat in on college biology and business school classes, and listened closely to several encounters between biologists and managers outside their company settings.

The Academic Network

While some of the earliest biotechnological entrepreneurs were themselves scientists, later entrepreneurs and the executives they hired have business school training. Nevertheless, most start-up firms are modeled on university laboratories, with functional groups such as production, operations, marketing, and sales scarcely existing. Most new companies have just 15 to 40 employees, only a few of whom work in management, finance, accounting, and staff support. Even in the "large" older firms such as Biogen, Cetus, and Genentech that have 300 to 700 employees, non-research staff still constitute a small minority compared with bench scientists—Ph.D.s and postdocs in wet biology—and laboratory support personnel such as technicians, dishwashers, computer engineers, and electronics technicians. A 4 to 1 ratio of scientists to non-scientists is typical for many firms.

Founders usually recruit bench scientists fresh from the government-funded laboratories of top universities, which conduct basic scientific research. Indeed, most of the firms are normally set up with the close collaboration of a high-ranking university scientist, who fills positions from among his or her professional associates. Entrepreneurs often recruit these scientists by promising that some of their time will be reserved for "pure" research, as well as by offering high salaries and state-of-the-art equipment.

Some small firms can trace nearly their whole staff to the professional "kinship networks" of the founding scientists. At one new company I visited, a vice-president for finance and his secretary were the only non-scientists in a group of 18. And except for two "distant cousins" with special expertise, all scientific staff members traced their professional geneology to the firm's two founders, who were professors at nearby universities and former grad-school buddies.

Managers in biotechnology companies have not developed similar networks because they have more diverse backgrounds. The earliest biotechnology executives often had backgrounds in venture capital or finance. More recently, companies have sought people with marketing experience. Most of today's managers have MBA degrees, with the exception of two small but notable groups: entrepreneurial scientists and industrial R&D managers.

The entrepreneurial scientists, like their counterparts in other high-tech industries, may be members of an endangered species. As companies are transformed from research houses to production facilities, many of these entrepreneurs will be pushed from operating management up to positions on companies' boards of directors. Some who stay on assimilate the culture of the job. One senior biology professor and company founder sounded like a venture capitalist as he told a student seminar on biotechnology opportunities: "There are three major topics to keep in mind at every step of your plans. The first is money. The second one is money. . . . And the third is also money!"

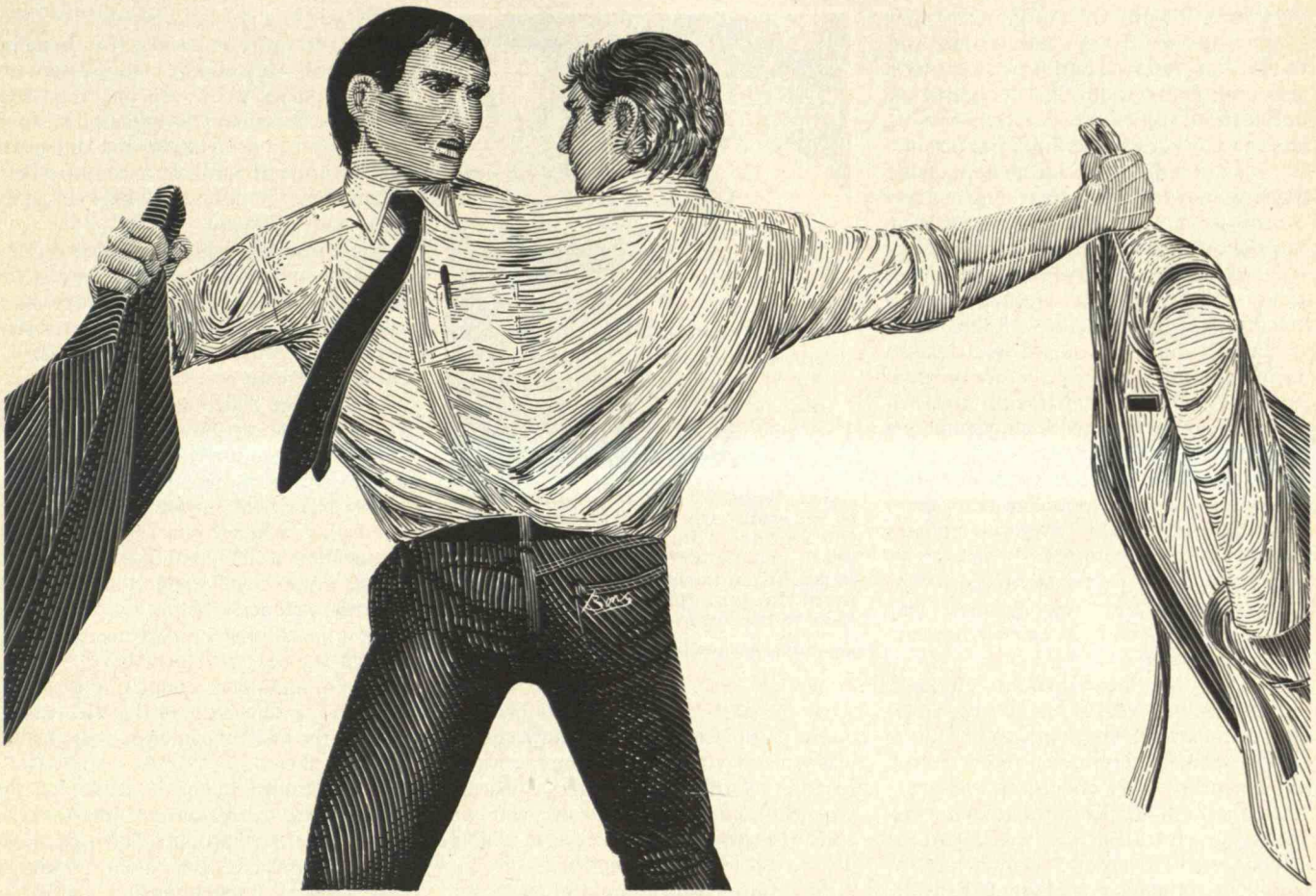
The immigrant R&D managers from large pharmaceutical and chemical companies such as DuPont have long since assimilated managerial concerns. They are on a normal track for "industrial science managers," and socialized to large bureaucractic organizations that are oriented to tasks and products. Their professional culture can clash as much with that of academic scientists as the culture of their finance-schooled managerial colleagues.

In their native habitats, both academic scientists and high-tech managers are high-status individuals. Presidents, CEOs, and entrepreneurs are top people in the high-visibility world of high-tech business. Biologists and most postdocs in these companies come from elite university departments. They are at the cutting edge of major scientific discoveries, well-funded, and in the forefront of public discussion of science.

Each group is also used to running its own show. The scientists, as laboratory heads or faculty researchers in universities, direct work in an environment relatively free of immediate administrative constraints. They regard managerial constraints as "external" and virtually antithetical to the practice of science. However, in the firm, executives direct and manage—and have the power to hire and fire—most of the bench scientists.

Still, managers cannot always capitalize on their power. In their expertise, biologists control a kind of "secret knowledge,"

In their native habitats, both scientists and managers are high-status individuals used to running their own show.



largely inaccessible to non-scientist managers, that they can use to fend off managerial forays into the details of laboratory practice. For example, any biotech executive could describe "cloning a cell line," but the practical details of successful cell fusion, or of selecting and growing a colony free from infection, are dense craft activities whose pitfalls and subtleties escape those without hands-on experience. Of course, managers can use their own detailed knowledge of finance and accounting to counter with another type of expertise.

Differences in Style: Cultural Patterns

Managers and scientists view themselves as being in—and from—different culture-worlds, and a number of signs point to the differences. Contrasting styles of dress represent one way of marking separate group identities in the company environment. Scientists tend to preserve their university "laboratory casual" style: blue jeans or slacks and sport shirts for men and women. Laboratory heads may keep a jacket and tie handy for meetings with upper managerial staff, but only at the research director's level does that attire seem common. By contrast, the business and managerial group tends to business suits for both men and women. Support staff in the managerial area dress more formally, too: the men wear jackets and ties, and the women dresses and heels.

Anyone who crosses the geographical and social lines of a firm stands out at a glance. Employees are acutely aware of these differences and often poke fun at the apparel of those from the "other" side. One embarrassed scientist wearing a business suit in the lab felt compelled to explain that "I have to chair a board meeting today, so I can't come in looking like I usually do."

Another turf marker is the set of images that grace the walls of labs and executive areas. Mahogany row—the managers' corner of the building—is often decorated with designer-coordinated modern art. Rented plants abound. Executive offices, foyers, and meeting rooms seldom sport any personalized decoration such as informal staff photos. Laboratories, by contrast, display motley collections of nature posters, informal photos of lab members and activities, cartoons poking fun at the scientists and their work, and, occasionally, representations of data.

Managerial and scientific work styles—including patterns of everyday, practical activities and conversation—also differ. Executives write, phone, manipulate electronic data, plan, and try to raise money. They meet with others to gather information, form opinions, share gossip, and make decisions, mobilizing and directing managerial staff and scientists alike. The classic observations by Henry Mintzberg of M.I.T. show that executives' work is extremely fragmented; they rarely spend

Managing for Success: The Genentech Story

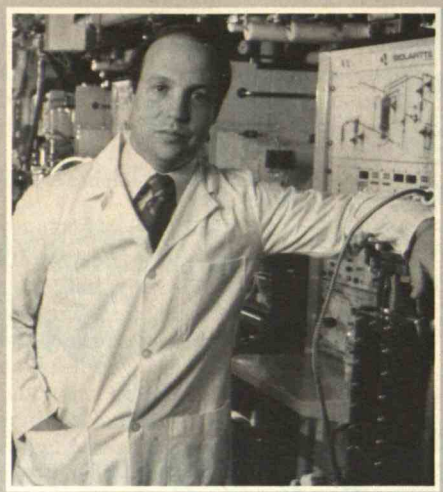
BY ALISON B. BASS

THE "Hertz" of the biotechnology industry doesn't have corner offices, reserved parking spaces, or an executive dining room. That's because the president of Genentech, Robert Swanson, doesn't consider such "fluff" important.

"It's just a distraction from doing good science," says Swanson, revealing in a few words why his fast-growing firm is so successful. Swanson may dress and think like a hard-nosed executive, but he shares many of the egalitarian attitudes that his scientific recruits brought with them from academia. And he has used that dualism in his own personality to create an environment at Genentech that encourages scientists to do creative work while adhering to concrete business goals.

"We've tried to achieve a mix of hard business goals and a looseness of structure at the individual level," Swanson explains during one of his whirlwind business trips to Boston. "We want scientists to follow their own noses and work on projects they find exciting—within the general direction of the company."

Swanson is well aware of the "cultural" differences between the molecular biologists who develop his company's products and the people who market them and run the business. As an undergraduate chemistry major at M.I.T. and a graduate student in M.I.T.'s Sloan School of Management, Swanson was immersed for a time in both cultures. Ultimately, he decided he would rather work with people—and numbers—than with laboratory test tubes. But he retains an appreciation for and understanding of science that is relatively rare among MBAs.



At 37, Robert Swanson is president of the company widely considered the leader of the new biotechnology start-ups. He achieved this success in part by understanding how to meld the two cultures most important to biotechnology.

Tensions between business and scientific staff have created problems in many of the new biotechnology companies, and may have led to the recent resignation of Biogen's Walter Gilbert, a biologist and Nobel laureate who was chief executive officer of the firm. Gilbert departed after Biogen reported a net loss of $13 million on revenues of $31.4 million for 1984, and laid off 13 percent of its staff.

Comparing Biogen with Genentech—two companies known for attracting the top scientists in their field—is inevitable. In 1984, Genentech turned a profit for the sixth year in a row and expanded to 697 employees, up from 23 in 1978. Some industry observers say the contrast between the companies points up just how successful Swanson and his scientific partner, Herb Boyer, a professor at the University of California at San Francisco, have been in handling the differences between managers and scientists.

Right from the beginning, Swanson says he had a relatively free hand to run the daily operations of Genentech. Boyer himself, perhaps reacting to strong peer criticism that he was "selling out to industry," chose to remain at UCSF and downplay his role in the fledgling company, serving in a part-time capacity on its board.

Swanson has another explanation for Boyer's low-key profile: "Unlike many others in the field, he wanted to create an atmosphere where young scientists got the credit. You don't see his name, for instance, on the insulin paper [in which Genentech scientists reported their first success in cloning human insulin], even though he was very involved in that effort." On sabbatical from UCSF this year, Boyer is spending more time at Genentech, and for the first time in eight years he has an office there.

While Biogen staked its future on the cloning and manufacture of interferon, a new and untested product, Swanson chose insulin, a product with a large existing market, as his company's first venture.

"We also cloned [alpha] interferon," Swanson hastens to add. "The overlap of really interesting scientific research and great business opportunities is more than sufficient in this field to avoid conflict—if you're managing the business well."

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more than 10 to 15 minutes at one activity, except for scheduled meetings.

Scientists read, confer, mix chemicals and biological substances, prepare gels, operate experimental and recording devices, examine machine outputs and computer programs, and compose reports, articles, and grant proposals. Their work, like that of managers, is a densely textured, interactive process, but with a strong academic flavor. As one young postdoc said: "[The company]'s just like a university lab . . . we all go up to the campus for seminars. . . . We don't have any business types around here!"

The Long and Short of Time

Managerial and scientific groups work largely in isolation from each other in genetic-engineering companies. But the two groups must meet—often uncomfortably—to set schedules for completing projects, including internal milestones, and to prepare business plans charting the future of the company across a wide front. This process highlights differences in the time frames of the two groups that make agreement difficult. Although entrepreneurs in volatile biotechnology start-ups often write long-term business plans to seek outside investors, everyone recognizes that such plans are flexible.

Managers see themselves as capable of both short-term and long-term planning, but economic pressures from creditors and investors force them to concentrate on quarterly financial reports rather than five-year plans, and they consider this near-term focus an aspect of their native realism. "Managers know that milestones have to be met," one company board member told me. "They negotiated the deal, and they must be able to explain to a partner why they haven't gotten to a goal."

Friday Night Beer Blasts

In the early days of Genentech, with Boyer sitting on the sidelines at UCSF, Swanson was left to alleviate the fears and anti-industry sentiment of his new scientific staff. And he did so by making them privy to the company's business decisions—by including them as part of a team.

"The scientists were aware of the benchmarks we needed to achieve and of the deadlines in getting a product out," the stocky, broad-shouldered CEO says. "And there have been many times when they've worked until 11 P.M. to get the job done." The fact that 90 percent of Genentech's employees are stockholders—through a special option made available to the entire staff—certainly doesn't dampen that carefully fostered sense of teamwork.

At the same time, Swanson is adamant about keeping his fast-growing company as democratic and loosely structured as possible. "Everybody has a uniform," he says, but when one uniform is no more important than another, the differences are not as compelling. To illustrate his point, the 37-year-old millionaire [from his shares of Genentech stock] tells—with obvious relish—of an incident that occurred while he was escorting visiting European dignitaries around the company's facility in South San Francisco.

"We have a scientist who has long hair and always wears grubby jeans," explains Swanson, who is himself impeccably dressed in a dark-grey pin-striped suit and expensive red-silk tie. "As I was taking the group around, we passed him sitting in the hallway, his foot up against the doorjamb.

Swanson may think like a hard-nosed executive, but he shares many of the egalitarian values of his scientific staff.

It was obvious he was thinking about some important technical problem.

"I said 'Hi Bill,' and he said 'Hi, Bob,' and he went right on thinking. He knew he didn't have to jump up because I was the president. I think that impressed our European visitors; it would never have happened in another company."

Swanson has also made an effort to bring together the disparate elements of Genentech's staff as much as possible. Despite the advantages of having the marketing department close to the executive offices, Swanson has kept it next door to the research division. "If people are bumping into each other in the bathroom, they've got to talk to each other."

Employees from the research, marketing, and business divisions also end up talking over glasses of beer at the company's regular Friday night "ho-ho." Swanson himself wore a grass skirt to the company's Hawaiian ho-ho, and he and Boyer dressed up as Tweedle-dum and Tweedle-dee at last fall's Halloween ho-ho. Swanson was Tweedle-dee. And there are days, he says, "when I'll come in without a suit and tie if I know I don't have any important business meetings."

As Genentech passes the $70 million mark in annual revenues, however, those days are vanishing. Swanson is intent on transforming Genentech from a small startup that licensed its first two genetically engineered products—human insulin and alpha interferon—to other pharmaceutical companies into a powerful drug firm in its own right. From now on, Genentech plans to manufacture and market most of the products it develops.

At this point, Swanson says Genentech is shepherding four of its own recombinant-DNA products through human clinical trials: human growth hormone, which may be used to treat growth deficiencies among children; tissue plasminogen activator, for use in dissolving blood clots that may cause some types of heart disease; gamma interferon, for possible use as an anticancer or antiviral agent; and tumor necrosis factor, a protein that, true to the Greek derivation of its name, has been found to kill tumor cells in animals.

But if and when Genentech becomes the giant Swanson has in mind, how does he plan to retain its loose atmosphere, its sense of family? "By keeping the essence of smallness. Other companies have done it and so can we," Swanson replies, displaying the unruffled confidence that has carried Genentech safely through the stormy waters of a pioneering industry. □

ALISON B. BASS is a senior editor of Technology Review.

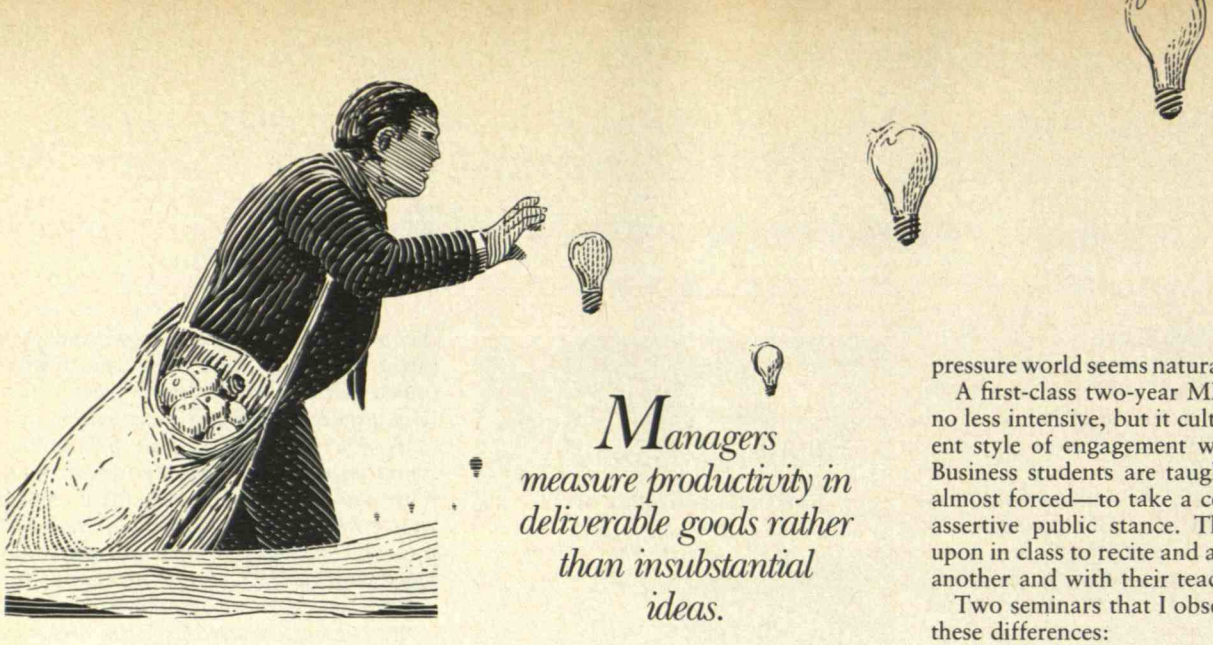
Executives complain that they have no time for long-term studies. "Long-range plans? I can barely get past the quarterly reports to do an annual report," one biotech CEO exclaimed when I asked him how frequently he revised his long-range plans. "The short run is what counts. If you don't make it in the short run, the long run doesn't matter."

Scientists, in contrast, set their sights on distant and perhaps indistinct goals. They regard such open-endedness as appropriate to scientific work, which is drawn continually forward by the questions and results that nature reveals. Since the answers are hidden, blocking out every stage toward their discovery—predicting the milestones demanded by mangement—is futile. Scientists thus claim to have the long view, but deny that they can plan it in the style that managers require.

Managers accuse scientists of never having an end in sight and see the open-ended approach to planning as unrealistic. "The scientists' biggest problem is a lack of focus," said one exasperated manager. "You can't afford diverse experimentation."

Scientists conversely see managers as limited by their shortsightedness. When executives complain that they have no time to make long-range plans, scientists accuse them of an incapacity to do so, viewing that trait as a generic aspect of managerial character. "The marketing people don't understand how the process of science works," a top consulting scientist explained. "They're just always stuck in the present."

This contrast in attitudes showed up clearly in a conversation I observed between a biotechnology company's CEO and a senior biology professor. Discussing the type of research support that his company required from university scientists, the CEO emphasized "specific expertise



Managers measure productivity in deliverable goods rather than insubstantial ideas.

and . . . project goals such as proving the safety and efficacy of a specific drug." The professor countered that "short-term considerations may lead to long-term debilitation of the university's value to industry." He argued that the firm should "invest" in the university's long-term science-generating capability by "unrestricted but focused" funding of research and even endowment of fellowships.

For the CEO, the real world plainly includes specific, bounded projects whose funding is driven by short-term considerations. He wants to know which institution gives the best deal today. The professor uses business rhetoric—such as "investment"—to argue his case for open-ended funding. Unfortunately but not surprisingly, the conversation does not bring the two men closer to agreement.

These differences in outlook partly reflect the two groups' views of their own development—another aspect of the contrast in their cultures of "time." Managers see themselves as rather unproblematically adult and fully formed human beings. Their careers may continue to advance throughout their lives, but their essential nature is complete when they gain their first executive position. Further advances entail more of what they already have: responsibility, authority, and financial reward. Managers connect their own maturity with their definition of the real world—one full of finite economic activity. Productivity, for them, is usually measured in deliverable goods rather than insubstantial ideas. "When they say real, they mean money," declared one company biologist.

Managers often regard scientists as immature or adolescent. Staff at Biogen, for instance, referred to a team of postdocs that Walter Gilbert brought in from Harvard as "the hobby group."

Biologists, on the other hand, see their own development as a continuous movement throughout their lives. Because scientists are taught to prize intellectual concerns over economic, emotional, and social ones, they see their growth as occurring in the realm of productive "ideas." Intellectual growth usually stands for growth in general to them. Scientists consider managers not as finished adults but as cases of arrested or frozen development. No wonder biologists and executives have trouble cooperating with and understanding each other.

Two Types of Training

The orgin of many of these cultural patterns can be traced to education. Potential biologists often start to specialize in science as early as high school. In college, they begin a series of time-consuming course activities, especially labs, that inexorably push the arts, humanities, and social sciences out of their schedules. These years of training in basic science emphasize passive learning. Then doctoral candidates must design and complete a relatively solitary piece of research that requires at least three to five years of 10-to-14-hour days in the lab. Biologists are gradually introduced to the contestible assertions of their discipline in advanced graduate seminars and encouraged to argue their positions. Only after completing their doctorates do they begin to work in more integrated research teams and assert themselves in a cooperative, faster-paced arena.

To an anthropologist like myself, who has done field research in East European and West African agricultural communities, the single-minded focus, intensity, dedication, and isolation from other arenas of social life of many novice molecular biologists seems extraordinary. On the other hand, having worked for four years in university biology laboratories in the 1970s, I realize that this insular, high-pressure world seems natural to its natives.

A first-class two-year MBA program is no less intensive, but it cultivates a different style of engagement with the world. Business students are taught—sometimes almost forced—to take a combative, self-assertive public stance. They are called upon in class to recite and argue, with one another and with their teachers.

Two seminars that I observed illustrate these differences:

☐ Before the first meeting of a graduate biology seminar at M.I.T., about 40 students sit in rows facing a blackboard, talking quietly among themselves. Talk stops immediately when the professor arrives, and there is a rustle of paper as students ready their pens and notepads. Without a word, the teacher strides to the blackboard and writes his name, the course number, meeting times, and office hours on the board. The students diligently copy this information. The professor then launches into an introduction to the course material. He dominates the talk, aside from a few tentative questions from students, who write extensive notes and address only the teacher if they speak at all.

☐ A class at Stanford Business School has a very different ambience. The classroom is built as an amphitheater. Tiers of seats with writing tables form a semicircle facing the professor's "stage." Arriving students place their foot-long nameplates in the slots before their seats. Then they congregate in small groups, buzzing on about their work assignments and course topics. The teacher challenges groups and individuals to answer preset problems about "cases," contrasting one group's ideas with those of another to stimulate argument. Students have a forthright, almost brash style of presenting their views, and they earn kudos for the "delivery," considered an integral part of the solution.

The business school method of teaching often limits students to the issues presented in case-study handouts. Students thus learn to analyze and make decisions about clearly bounded problems; then they skillfully argue about their choices. I am not implying that business students do not learn to think creatively, or that they are not given to careful analysis. Rather, I would suggest that this style of pedagogy cultivates a habit of working within the confines of a problem whose limits are finite and, preferably, knowable.

Continued on page 74

Masterslice and the Engineering Design System

IBM

To: Abby
From: Roger
Subject: IBM Technology

I've been reviewing some of our past and present technological achievements, and it occurred to me that the scientific, engineering, and academic communities might like to know more about them. Will you select a topic from the following list? Thanks.

Vacuum tube digital multiplier
IBM 603/604 calculators
Selective Sequence Electronic Calculator (SSEC)
Tape drive vacuum column
Naval Ordnance Research Calculator (NORC)
Input/output channel
IBM 608 transistor calculator
FORTRAN
RAMAC and disks
First automated transistor production
Chain and train printers
Input/Output Control System (IOCS)
STRETCH computer
"Selectric" typewriter
SABRE airline reservation system
Removable disk pack
Virtual machine concept
Hypertape
System/360 compatible family
Operating System/360
Solid Logic Technology
System/360 Model 67/Time-Sharing System
One-transistor memory cell
Cache memory
Relational data base
First all-monolithic main memory
Thin-film recording head
Floppy disk
Tape group code recording
Systems Network Architecture
Federal cryptographic standard
Laser/electrophotographic printer
First 64K-bit chip mass production
First E-beam direct-write chip production
Thermal Conduction Module
288K-bit memory chip
Robotic control language
Masterslice and the Engineering Design System

Roger-
Let's tell about our innovative method of designing and integrating logic chips into our large computers.
Abby

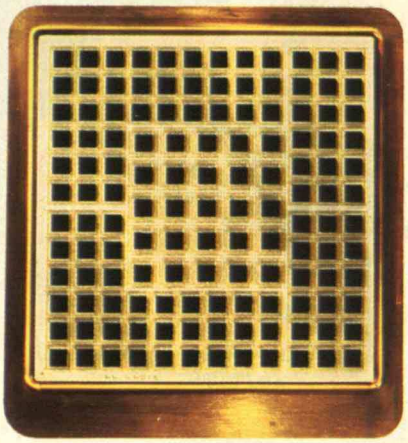
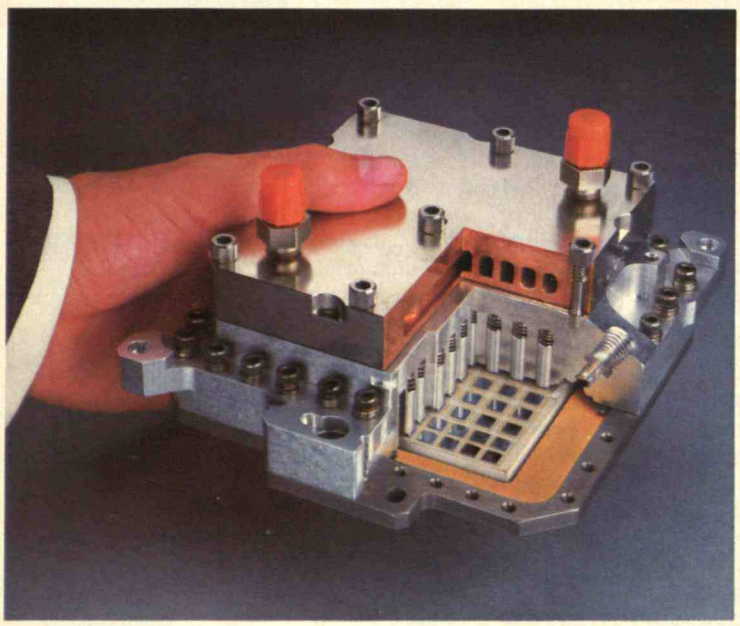


Figure 1: *The logic module used in large IBM computers (cutaway below) is part of the industry's densest circuit packaging. The electronic chips mounted in each module (right) were made through IBM's Engineering Design System and the masterslice concept: customize where necessary, standardize where possible.*



As computer applications continue to expand, designers of large computers are faced with many challenges. One of the biggest of these is designing semiconductor chips: not only do engineers have to design chips to contain the desired function, but they must also integrate the chips into the rest of the system and accomplish this quickly and inexpensively.

For nearly two decades, IBM designers have been leaders in this field, pioneering the technologies of chip customization, automated design, and automated manufacturing. In the mid-1960s, IBM researchers began developing a chip customization technology—known as gate array or masterslice—as well as a totally integrated set of design automation tools called the Engineering Design System.

The first masterslice chip came off IBM production lines in 1967 and was part of the System/3 announced in 1969. Growing increasingly important as an element in IBM computers, masterslice became the basis for the logic in the System/38 in 1978. This marked the first major impact of masterslice technology on computer architecture, making masterslice a driving force in semicustom, large-scale integration of chips in the computer industry.

In masterslice, a predefined pattern of circuit elements is fabricated in an area of a silicon chip called a cell. The pattern is then repeated so that almost the entire chip is covered with identical cells. In this manner, many chips

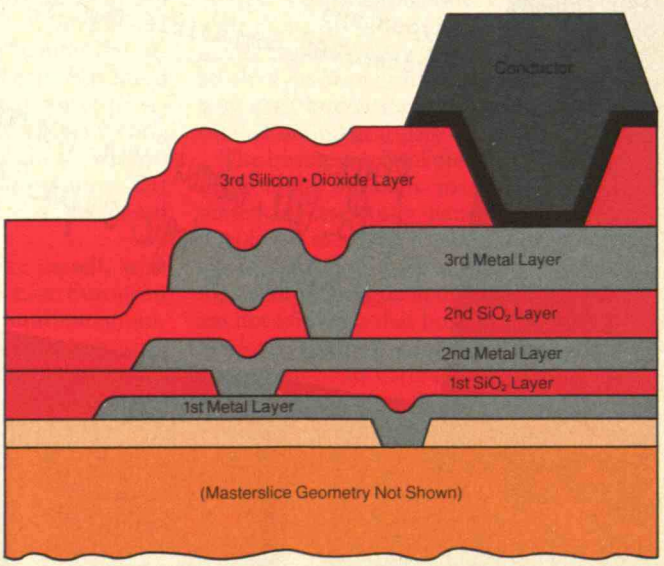


Figure 2: *This simplified side view of a logic chip shows three layers of metallization (along with three layers of insulating silicon dioxide) that are put on top of the masterslice to produce a semicustom chip. The metallization process enables designers to customize chips for a specific job. And a standard "base"—the masterslice—allows quicker turnaround times and lower manufacturing costs.*

may be produced with identical arrays of identical cells.

Customization takes place in "metallization"—the adding of alternate layers of insulators and metal wiring interconnections over the masterslice pattern of the circuit elements. This gives chip designers the freedom to make hundreds of variations in their design and still maintain the economic standardization of parts.

Masterslice technology has grown into an important process for implementing logic in IBM products. It is the basis of the 1,200 logic chips that make up the 500 different logic configurations of the central processing unit of IBM's largest computers, the 308X family.

IBM's Engineering Design System (now a full family of integrated design tools) has a data base that contains a complete description of each chip and its relation to the rest of the system, from the physical properties of individual devices to the requirements of the entire logic system of the computer. Thus, this design system enables the needs of a large system to be reflected in the design of its smallest components.

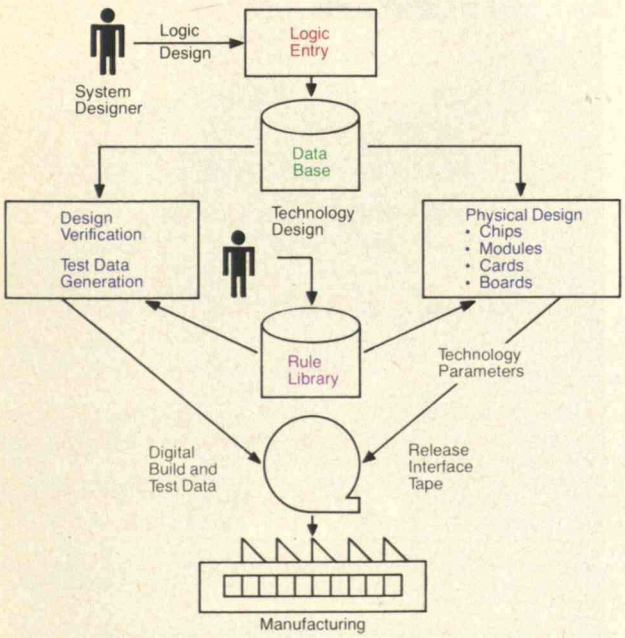


Figure 3: *With IBM's Engineering Design System, machine designers use terminals to input logic functions for a chip and establish a data base. Through simulation, the system provides logic verification and performs logic delay checking. Test patterns are then automatically generated for each part. In the meantime, physical design of the chip is done with computer programs that perform the following tasks: circuit placement, I/O assignment, wiring, and checking. All physical design information is then transformed into shapes, patterns, and precise locations of interconnections and circuit elements required for manufacturing.*

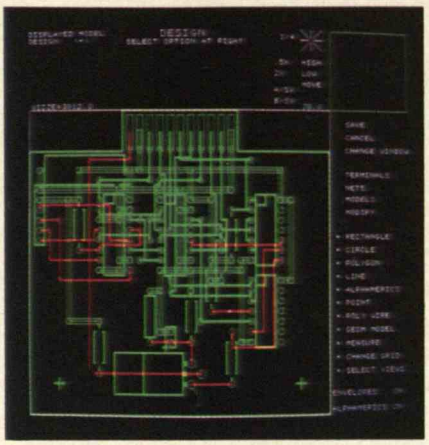


Figure 4: *Shown here is a display screen from the Interactive Graphic System (IGS), one of the many Engineering Design System tools developed by IBM to speed chip development and implementation. IGS is a powerful shape manipulation tool used to design new masterslices.*

The thousands of individual software modules of the Engineering Design System can be used to take a chip from initial design, through simulation and testing, to manufacture. Linking such a wide range of functions through common interfaces to form a total system is a feat unmatched in the industry. A designer using this system can take a chip from the start of the physical design stage to the manufacturing line in about six days.

Many engineers, scientists, and programmers throughout IBM contributed to the development of masterslice and the Engineering Design System. Their contributions are only part of IBM's continuing commitment to research, development, and engineering.

IBM®

NATO's Improved Conventional Weapons

BY MICHAEL T. KLARE

If the past five years of NATO's history have been dominated by a debate over nuclear weapons—the Pershing II and cruise missiles now being installed in Europe—the next five are likely to be dominated by a debate over conventional weapons. At the behest of Gen. Bernard W. Rogers, the allied commander in Europe, Western nations have accelerated programs to develop a new generation of precisely guided nonnuclear missiles, bombs, shells, and other weapons. And last November NATO members adopted a "deep-strike" strategy for using these weapons. In a European war, the Western alliance would use its advanced conventional arsenal to bombard Warsaw Pact reinforcements, airfields, command and communications posts, and other installations as far as several hundred kilometers behind the East German border.

On first consideration this strategy has much to recommend it. NATO's long-standing policy has been to resort to tactical nuclear weapons if necessary to defend Western Europe, even if Warsaw Pact armies are attacking only with conventional arms. However, tactical nuclear bombs would devastate the densely populated nations of Europe, and debates over the plan to use them have been intense and divisive. Many Western Europeans are keenly interested in improving conventional defense.

A new generation of weapons will deliver clusters of nonnuclear explosives precisely on target. These munitions can help defend front lines, but they could also ignite nuclear war.

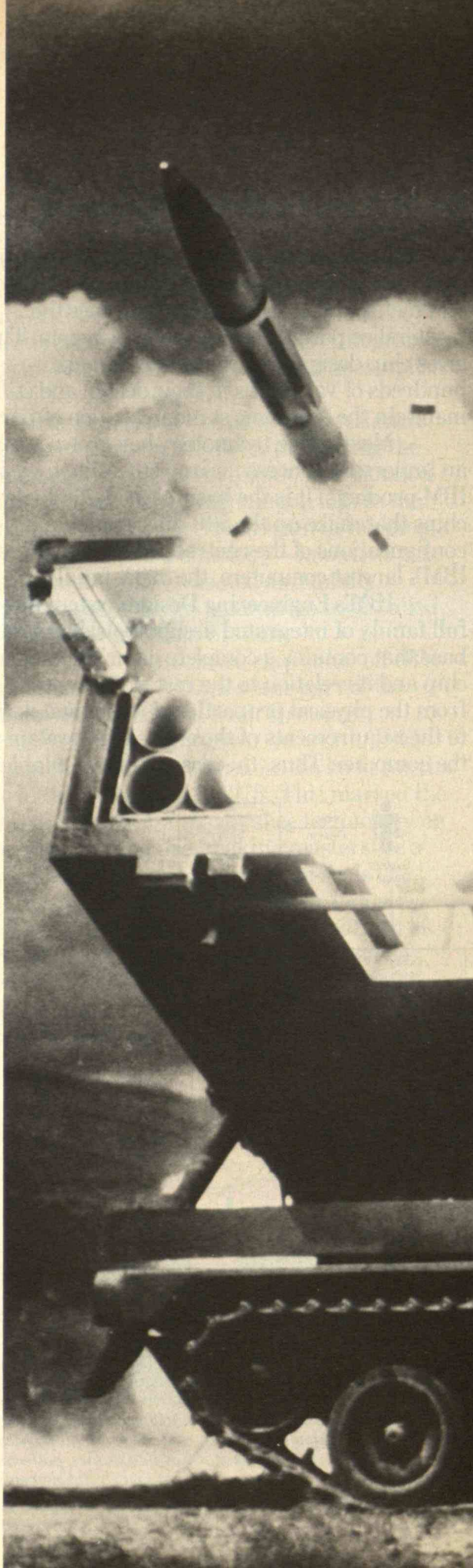
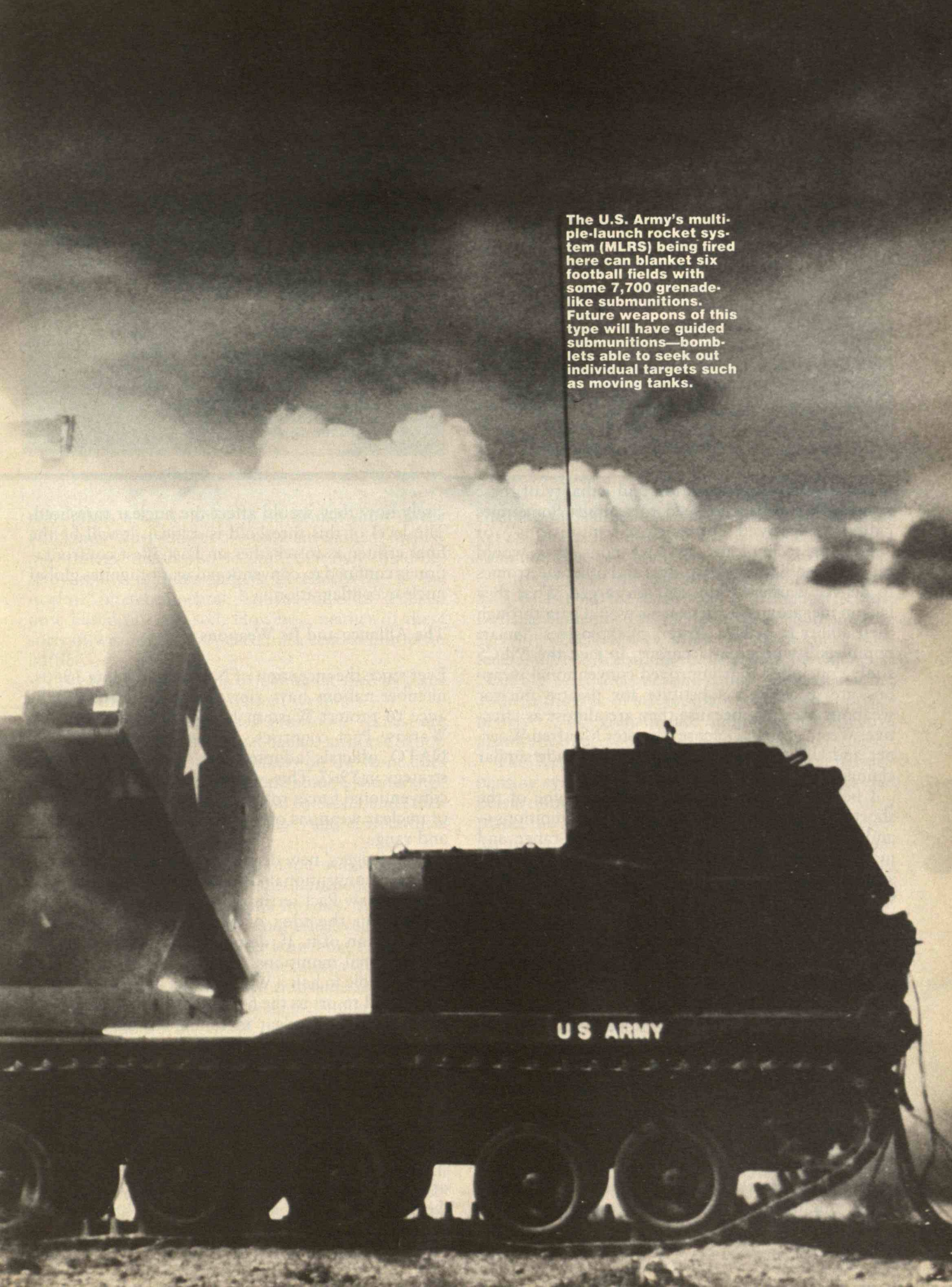


PHOTO: U.S. ARMY



The U.S. Army's multiple-launch rocket system (MLRS) being fired here can blanket six football fields with some 7,700 grenade-like submunitions. Future weapons of this type will have guided submunitions—bomblets able to seek out individual targets such as moving tanks.

A new U.S. Army weapon, a guided projectile known as the Copperhead, hits an M47 tank at the White Sands Missile Range in New Mexico. A laser located either on the ground or in an aircraft is focused on the target, and the Copperhead homes in on the light from the laser. In place of a warhead, this inert round carried an instrument package to monitor flight performance. The nearly one-shot, one-kill capability of such precision-guided weapons is expected to revolutionize the conduct of war.

Rogers argues that the ability to carry out a deep-strike strategy would "raise the nuclear threshold"—allow NATO forces to repel a more massive Warsaw Pact attack without resorting to nuclear weapons—and most analysts agree. As the House Armed Services Committee said in a 1983 report, the new generation of nonnuclear weapons would delay the point "where 'the wargame plan' says go nuclear or lose." Other proposals for improving NATO's conventional defenses, such as that by the Union of Concerned Scientists entitled *No First Use*, and the report by the European Security Study (ESECS) called *Strengthening Conventional Deterrence in Europe*, are based on the same premise.

But the very sophistication and lethality of these non-nuclear arms may lead to trouble. Sometimes called "improved conventional munitions" or "emerging technology" (ET) weapons, they would rely on the ability of computers and other electronics to deliver warheads precisely on target. What they lack in megatonnage these arms would gain through their ability to deliver clusters of explosives ("smart bomblets") with great accuracy. In fact, the ESECS study concluded that improved conventional weapons are a credible substitute for theatre nuclear weapons precisely because they are almost as effective. West German Defense Minister Manfred Woerner and U.S. Senator Sam Nunn have made similar claims.

I believe NATO can safely acquire some of the shorter-range improved conventional munitions—and should do so. However, the longer-range and more powerful weapons raise serious dangers, for several reasons. First, NATO plans to use them to wipe out key Warsaw Pact posts that, in addition to commanding a European war, are intended to warn of a strategic nuclear attack against the Soviet Union itself. Moscow could well respond to such an attack by launching its nuclear arsenal. Second, some of the same missiles that would deliver improved conventional weapons can also carry nuclear warheads. This is a formula for a tragic mixup: the Soviet Union would not be able to determine whether it is under nuclear or conventional attack. Third, if the Warsaw Pact developed and used improved conventional weapons of their own to attack Western Europe, that might simply hasten NATO's decision to go nuclear.

It would be a grave mistake for NATO to acquire improved conventional weapons, even with the most commendable of intentions, before ascertaining precisely how they would affect the nuclear threshold. The level of this threshold is critical. It will be the final arbiter as to whether an East-West confrontation is confined to conventional war or ignites global nuclear conflagration.

The Alliance and Its Weapons

Ever since the inception of NATO in the late 1940s, member nations have viewed it as a defensive alliance to protect Western Europe from invasion by Warsaw Pact countries. To perform that mission, NATO officials adopted the "flexible response" strategy in 1967. This calls for an initial defense with conventional forces followed, if necessary, by the use of nuclear weapons of progressively increasing yield and range.

Gen. Rogers' new deep-strike strategy, entailing a stronger conventional defense that extends deeper into Warsaw Pact territory, does not represent a retreat from the idea of flexible response but a modification of it. If, despite their use of improved conventional munitions, Western forces find themselves unable to halt a Warsaw Pact invasion, NATO would still resort to the first use of nuclear weapons. Rogers made this clear in calling for an improved conventional defense before the Senate Armed Services Committee in 1983: "We would always want to preserve the possibility of a nuclear response—to include a first-use option—in order to convince a potential aggressor that the risks of aggression outweigh any potential gains."

Improved conventional weapons come in a range of types. Some have already been deployed, such as the "smart" Exocet antiship missiles that Argenti-

Some missiles that would deliver conventional weapons can also carry nuclear warheads, a formula for a tragic mixup.

nian pilots used to home in on British ships in the Falklands War. Others are only envisioned, including strategic missiles so accurate that they could destroy many military targets as effectively as the nuclear intercontinental ballistic missiles (ICBMs) now based on U.S. soil. However, neither of these sorts of weapons is proposed for a central European battle.

Instead, NATO's goals would be satisfied by three types of improved conventional weapons.

☐ *Tactical precision-guided munitions* (PGMs) are intended to strike individual tanks, armored troop carriers, helicopters, and bunkers on the front lines of battle. These weapons include bombs, short-range missiles, and artillery shells able to detect and track their targets—even moving ones—and correct their course to make a direct hit.

Two early weapons of this type were the Soviet "Sagger" and U.S. TOW (tube-launched, optically tracked, wire-guided) antitank missiles. Such weapons were used with devastating effectiveness in the 1973 Arab-Israeli War. After launching such a missile, a soldier trains a sight on the tank; a wire trailing from the missile continually transmits course-correcting signals to it from the sight. Similarly, in the 1982 Lebanon War, Israeli pilots used missiles capable of homing in on radar to cripple Syrian air defenses. These PGMs and more sophisticated successors now being developed have what is termed a "high probability of kill per round": each missile or shell is very likely to disable its target.

☐ *Wide-area dispersal munitions* are intended to attack entire formations of vehicles or facilities such as artillery batteries, air bases, and fuel depots located just behind the front lines. Descended from the cluster bombs used in Vietnam, these weapons blanket an area as large as half a square mile with many submunitions, or "bomblets."

The cannister that delivers the submunitions may be a rocket. In his fiscal-year 1986 budget report, Defense Secretary Caspar Weinberger is requesting 72,000 rockets for 44 multiple-launch rocket systems (MLRSs). According to the report, one launcher "can fire 12 rockets beyond cannon range, covering an area the size of six football fields with approximately 7,700 grenade-like submunitions effective against both personnel and lightly armored targets."

The West German MW-1 "aircraft-mounted dispensing system" is a different type of wide-area dispersal munition. Slung beneath the fuselage of a plane, the MW-1 consists of an array 112 short ejector tubes, each of which carries dozens of submunitions. Different types of these submunitions can be fired against a variety of targets, including airfields, tanks, and personnel.

Today's wide-area dispersal munitions do not have guided submunitions. However, future weapons of this type will have bomblets able to seek out individual targets such as moving tanks and taxiing aircraft.

☐ *Deep-interdiction weapons* are intended to impair the Warsaw Pact's ability to support and control a battle by knocking out military bases, airfields, command posts, communications facilities, radar installations, and the like far behind the front lines. To do this, ballistic or cruise missiles will travel some 100 to 300 kilometers and release a variety of submunitions on structures, vehicles, and personnel, covering up to a square mile of area. Guided by sophisticated radars, these weapons are expected to

PHOTOS: U.S. ARMY

Introducing a new family of offensive weapons would trigger a dangerous new round in the conventional arms race.

be very accurate, with a 50 percent probability of landing within 30 to 40 meters of their targets. Because of their versatility and precision, conventional deep-interdiction weapons may well approximate the destructive potential of the smallest nuclear weapons in the one- to three-kiloton range.

No such weapons have yet been deployed, but many of the necessary technologies have been tested under the "Assault Breaker" program conducted jointly by the U.S. Army, Air Force, and Defense Advanced Research Projects Agency (DARPA). Although the tests were not altogether successful, many of the components—especially the missiles and submunitions—did work. In fact, the Defense Department plans to mount some of the smart submunitions tested in Assault Breaker on the MLRS rocket system. The long-range missiles that were tested could also be deployed with the submunitions as deep-interdiction weapons. However, until radar systems to track moving targets are improved, these weapons would mainly be useful against fixed targets such as bases, command posts, and radars.

Deep-interdiction weapons are being developed further under three related programs: the U.S. Army/Air Force Joint Surveillance and Target Acquisition Radar System (JSTARS), the same services' Standoff Tactical Missile (STM), and the U.S./British/West German Long-Range Standoff Missile (LRSOM). U.S. defense contractors have also proposed using several existing missiles for the deep-strike mission, including the Trident sea-launched ballistic missile, the Tomahawk cruise missile, and the CAM-40, a derivative of the Pershing II land-based missile.

Appropriate Weapons

Rogers has called for improved conventional munitions because he believes that the Warsaw Pact now enjoys a considerable advantage over the West in conventional military strength. While he wants to deploy all three types described above, he has placed special emphasis on the wide-area dispersal and deep-interdiction munitions—the longer-range and more powerful weapons. He believes that NATO's front-line forces are strong enough to repel the first echelon of Warsaw Pact invaders without using nuclear weapons, but that NATO does not have the strength in conventional arms to resist the second and third waves of forces. By using improved cluster munitions and deep-interdiction weapons, NATO forces would be able to weaken or destroy these "follow-on" forces before they reached the front, thus giving reinforcements time to arrive from Great Britain and the United States.

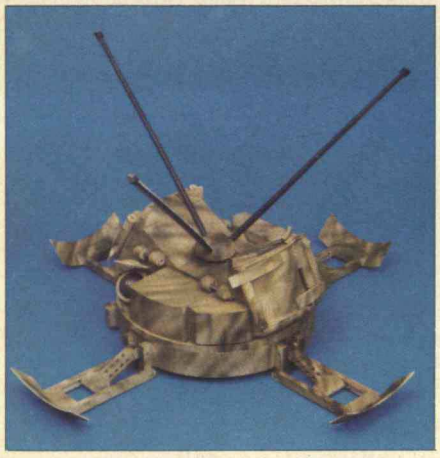
Critics have questioned Rogers' approach for a number of reasons. Some experts on military technology, including Steven L. Canby of C&L Associates in Potomac, Md., doubt that sophisticated weapons will perform as effectively as advertised. Others, including Jeffrey Record of the Institute for Foreign Policy Analysis in Washington, D.C., argue that emphasis on developing sophisticated arms and strategies for the deep-strike mission will divert resources better spent on NATO's front-line defenses. These analysts question whether the Warsaw Pact would in fact rely on succeeding waves of forces, or would instead use troops already stationed in Eastern Europe to mount a devastating blitzkrieg.

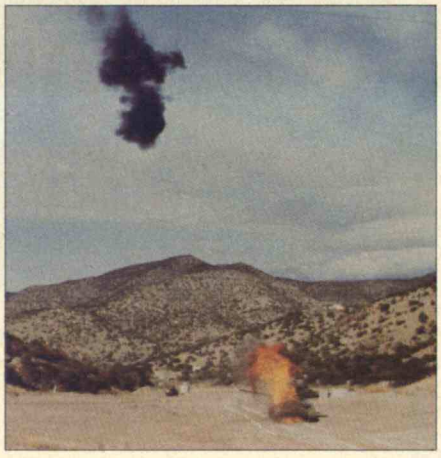
Still others, such as John J. Mearsheimer of the University of Chicago, contend that while Warsaw Pact forces are numerically superior to NATO's, they do not have the overwhelming advantage needed to wipe out NATO's well-established defensive positions. Proponents of this view are skeptical about Warsaw Pact capabilities, suggesting, for instance, that many non-Soviet armies would prove highly unreliable in any major East-West confrontation. To the extent that this viewpoint is correct, the need for improved conventional arms would be reduced.

Such doubts deserve careful consideration. However, my concern is mainly with Rogers' deep-strike strategy, the particular types of improved conventional weapons it calls for, and, above all, their effects on the nuclear threshold.

The strongest case can be made for deploying the tactical PGMs, which unfortunately Rogers has emphasized least. Many analysts believe that their nearly "one-shot, one-kill" capability has revolutionized the conduct of war. "If one can see a target," Henry Rowen of Stanford University and the RAND Corp. has noted, "in the absence of enemy interference, one will be able to hit it." This is "in marked contrast to wars of the past, in which hundreds of aircraft might spray thousands of bombs over the landscape to get a few on target."

Most analysts believe that the "PGM revolution" inherently favors the defense over the offense—especially in situations such as those that would probably prevail in a European war. Because the Warsaw Pact's forces would be both heavily concentrated and





The U.S. Air Force's Combined Effects Munition looks like a blunt-nosed bomb and is carried beneath an aircraft. After being released, it dispenses some 200 bomblets to destroy a variety of targets (above). As the Extended-Range Anti-Armor Munition (left) sits on the ground, its antennae detect an approaching tank and launch a Skeet submunition in its direction. The Skeet's infrared sensor in turn spots the tank and fires a projectile at it (right).

highly exposed during the opening phases of an attack, NATO's dug-in defensive units could use large numbers of PGMs to take a heavy toll of the invaders. As Mearsheimer wrote in *Conventional Deterrence*, "The increased firepower available to the defense makes it possible to turn each major defensive position into a 'wall of fire' that the offense can penetrate only by paying an exceedingly high price."

Wide-area dispersal munitions, if used against front-line enemy troops, might also strengthen the defense. They are likely to be as deadly as PGMs, as William J. Perry, then undersecretary of defense for research and engineering, wrote in 1978: "As long as the enemy moves, is warm, or presents a radar contrast relative to the background, he can expect to be defeated."

Even if the Soviets acquired PGMs and cluster munitions of their own, they would probably not gain an overall advantage. As long as defending forces remain in relatively protected positions, the attackers, being more concentrated and more exposed, should suffer far greater casualties from wide-area dispersal munitions and tactical PGMs. Thus, acquiring such weapons would strengthen NATO's defenses and decrease the likelihood that nuclear weapons would be needed to stop a Warsaw Pact invasion.

At some point, the use of enough tactical PGMs and wide-area dispersal munitions by both sides does pose a risk of escalation. The weapons' lethality combined with their high concentration along the East-West German border could produce an extraordinarily violent, destructive battle. As John Keegan of the Royal Military College at Sandhurst (the British counterpart of West Point) has suggested, "A high-intensity conventional war and a low-intensity nuclear war might inflict very much the same level of damage on any given piece of inhabited landscape." Wide-area munitions would be particularly likely to harm nearby civilian populations much as tactical nuclear munitions do. If that happened, the potential loser might well employ nuclear weapons to stave off defeat. Therefore, NATO should acquire only relatively short-range weapons whose destructive power would not approximate that of low-yield nuclear munitions. That way improved conventional weapons would strengthen the defense without increasing the risk of nuclear escalation.

PHOTOS: AIR FORCE MAGAZINE; AVCO

Marines prepare to launch a guided TOW (tube-launched, optically tracked, wire-guided) antitank missile. A soldier trains a sight on the tank, and a wire trailing from the missile transmits course corrections to it continuously. The TOW was first used in combat in the Vietnam War.

Blurring the Nuclear Threshold

Deep-interdiction weapons, promoted as having capabilities that approximate those of tactical nuclear weapons, are another matter. After suffering tremendous losses from such "near-nuclear" conventional weapons, the Soviets might choose to prevent further attacks by retaliating with nuclear arms. The idea that Moscow would be restrained from escalation merely because devastating attacks were carried out with conventional warheads is one of the "myths" behind the deep-strike strategy—as Daniel Goure and Jeffrey R. Cooper observed in a recent issue of *Comparative Strategy*.

The risk of nuclear war from a deep-strike strategy is all the greater because of its particular targets. The radar installations that the Warsaw Pact would use in a European war are also intended to warn Moscow if Pershing IIs or other nuclear missiles are directed toward the Soviet Union itself. Similarly, many of the Warsaw Pact air defenses, command posts, and communications facilities are part of the Soviet Union's own strategic nuclear defense system. Moscow could easily view even a conventional attack on these targets as a threat to its ultimate security and retaliate with nuclear arms. As Barry R. Posen of Harvard University suggested in a recent issue of *International Security*, Soviet leaders "might fear that an attack against its strategic command and control capabilities was a prelude to a large-scale American strategic nuclear assault." The result could be nuclear escalation.

Moreover, it is easy to assume that NATO will obtain high-technology weapons while the Soviet Union retains its present arsenal. This supposition is particularly dangerous in the case of deep-interdiction munitions. In the past, the Soviet Union has generally managed to duplicate Western advances in arms technologies. Should Moscow develop comparable deep-interdiction weapons, it could use them to knock out NATO command and communications posts, radars, bases, and reinforcements located throughout West Germany and the Low Countries. In that case, NATO itself might have to use nuclear weapons earlier instead of later. Introducing a new family of offensive weapons would in all likelihood

Continued on page 73

PHOTO: U.S. MARINE CORPS

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ABOUT THE COVER
George Segal's sculpture of art patroness Vera List, with friends, at the dedication reception for the List Visual Arts Center. Photo by Frank Revi, '86.

STUDENT VIEW

DIANA BEN-AARON

Covering the White House for *The Tech*

"Henry Kissinger's emotional crescendo last week that led to his threat of resignation began at a Washington press conference a few days earlier with an invidiously phrased question by a reporter for an underground paper called The Tech . . . "
Henry Brandon,
Washington correspondent
The Times of London.

On June 6, 1974, Peter Peckarsky, '69, represented *The Tech* at a State Department press conference. He asked Kissinger to reconcile two contradictory statements he had made under oath at different times, if the government were investigating him for perjury, and if he had hired a lawyer. Aides described the secretary of state as "annoyed . . . to tears" by the question. Later that month, Kissinger threatened to "resign unless cleared." Garry Trudeau based a *Doonesbury* comic strip on the incident.

There is no record of *The Tech* being invited to the White House for the next ten years. Last fall, however, (pre-election) I represented the paper at a White House press conference for college newspaper editors. No, we did not see the president, just to get that question out of the way. We did see, hear, and question United Nations Ambassador Jeane Kirkpatrick, Secretary of Education Terrell Bell, principal deputy Press Secretary Larry Speakes, and several other White House officials.

We converged on Washington armed with probing queries aimed to elicit the shocking truth about the horrors of the current administration. Predictably, we received very few direct, revealing answers. In fact, the most shocking thing we could reliably document was the immense difficulty of getting facts of any kind, good or bad, out of the Reagan White House.

Kirkpatrick delivered a 45-minute political science lecture describing the Cold War years as "secure, strong, prosperous, and hopeful," discounting the Soviet annexation of Eastern Europe, the after effects of the war on Europe, and the McCarthy witch hunts.

The other officials seemed more open to audience participation but, with the exception of Bell, released little more of interest. Their answers relied heavily on common knowledge and vague generalities. Sometimes they simply restated or focused on the question, or told the student about the question he "should" have asked.

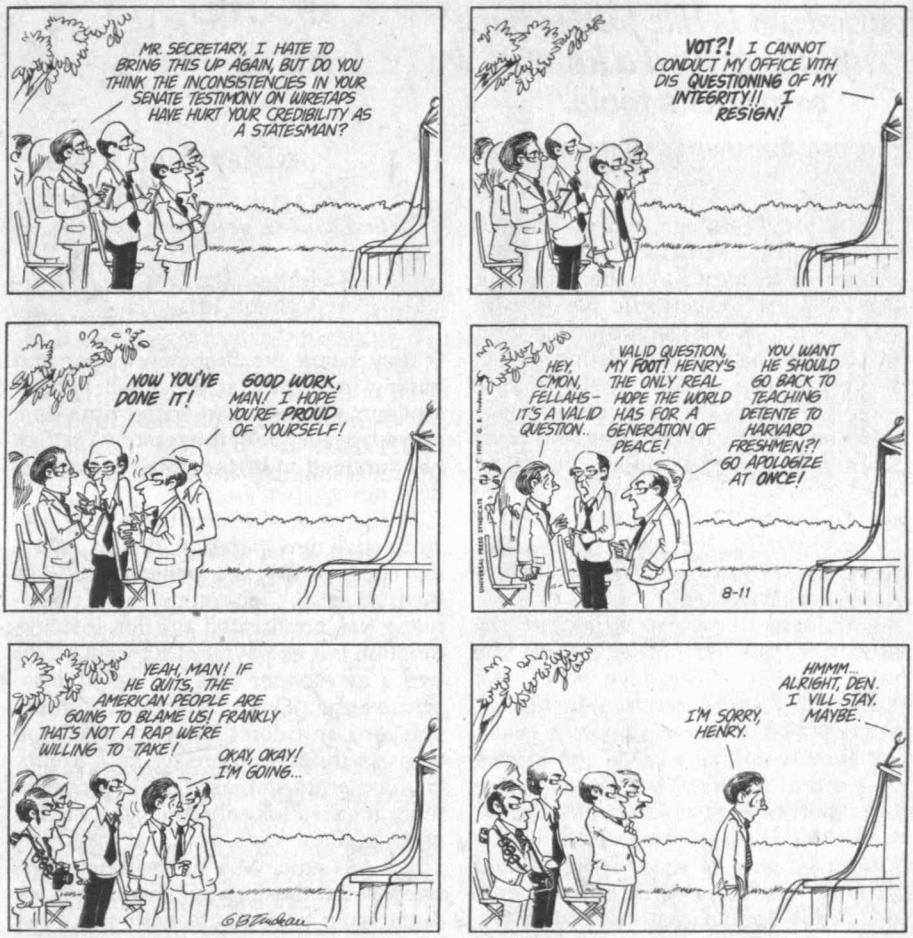
Speakes contradicted himself throughout his presentation. "Communication is a part of leadership. The American people give Reagan high marks for leadership. . . . I think the president has communicated with the public and the press," he said in response to questions about the campaign. Well, the president did not do it through his staff. To topical questions, Speakes said mostly either "No comment," or "At the time, there were reasons for it."

Is This "Catering" or "Reaching Out?"

A student asked him about efforts by the Reagan campaign to "cater to the college vote. Is this briefing part of that?" he said. Speakes claimed the timing of the briefing was unrelated to the campaign. "It's surprising that a president who is about to be the oldest ever has such appeal to the young," he said. Merrie Spaeth, special assistant for media relations, later referred to the exchange as "a question about what this administration is doing to reach out to young people."

A 20-minute lunch break was the only time we had to talk to each other. I met an editor-in-chief of a daily with 50 editors, the editor-in-chief of a biweekly at a school with 1,200 students, and a 50 year-old priest who was representing his seminary. We all agreed we were not

DIANA BEN-AARON, IMMEDIATE PAST EDITOR-IN-CHIEF OF THE TECH, *PLANS A CAREER IN JOURNALISM WHEN SHE COMPLETES A DEGREE IN HUMANITIES AND MATERIALS SCIENCE THIS YEAR.*



getting very useful information.

When we returned to the press conference room, the daily White House press briefing session was being broadcast live over the intercom. Every day at 12:30, professional reporters informally grill Speakes on current events. If that particular briefing was any indication, the sole point of the practice is to keep the lines of communication open.

"The President doesn't seem to endorse the high-growth scenario," a reporter was saying.

"Well," said Speakes, "some days he does and some days he doesn't."

A reporter asked a complicated question about protection for the steel industry. "You'll have to ask the proper people about protectionism tendencies. The president will decide," Speakes said.

Lester Kinsolving, a priest turned media gadfly, asked if the president were eating lunch with Jerry Falwell that day. "Why no, I don't think so. I don't know. I'll send someone to check," said Speakes. Another reporter later said Falwell had told her he was lunching with Reagan.

"The president said he'd be having little mini-news conferences. We're free this afternoon if he is," said someone else. Speakes said the president was not free that afternoon.

"Well, what's he doing for lunch, if he's not eating with Falwell," a voice persisted. "Is he brown-bagging it or what?" Mad laughter. Speakes reminded the Fourth Estate that the president had already spoken on the record for 40 minutes this month.

Finally Kinsolving burst into a tirade asking why the president was so insulated from the press. "What is this coccoon policy?" Kinsolving grumbled. "Mr. Reagan is a very good speaker, very able with the press. Why do you have the impression the president can't handle the press without you or Baker or Deaver as a fall guy?"

"That's the most complicated question you've ever asked, Lester," said Speakes. ". . . Do you realize all these college students are listening? Do you think they have any idea how to handle Lester?" The intercom fell dead.

With laughter and relief, we realized we were not the only reporters frustrated by the difficulty of getting news out of the Reagan White House. Newspaper stories about the White House are usually assembled from multiple, often unofficial sources, a press aide told us afterward. "The daily briefing sessions are not televised. I hope they never are . . . there aren't a lot of answers that come out of daily briefing sessions," he said. But as Peckarsky realized, sometimes the unanswered questions can be just as important as the answers.

"Learn how to put out a newspaper while you're at it."

sign on
The Tech's Coke machine.

The usual fate of a college newspaper at a large university is frantic jockeying for staff positions and editorships and a constant struggle to balance the books. *The Tech* has the problem in reverse: No one comes to M.I.T. to learn journalism. We always have trouble recruiting staff because almost all M.I.T. students are here to get a professional education—and they do not see newspaper work as a promising profession. Time spent at *The Tech* is time not spent studying fluid mechanics, doing a UROP, or working part time to pay tuition.

But as Professor J.D. Nyhart said when he was Dean for Student Affairs 15 years ago, student activities are really the "sixth school" of the Institute. "I got a second education from working on student publications," says *Tech* columnist Stewart Cobb, '85. "I can look at a book or a magazine or an ad and know how it was put together. I also have some experience in journalism and graphic design in case some day I decided I don't want to be an engineer."

As James Thurber observed, falling back on journalism is somewhat like falling back full-length on a kit of carpenter's tools. Some *Tech* alumni have

"Falling back on journalism is like falling back full length on a kit of carpenter's tools."

chosen to do just that, among them Karen Wattel Arenson, '70, a business reporter for the *New York Times*; Paul Schindler, '74, an editor of *Information Systems News*; and the infamous Peckarsky, who covers the White House for the Washington Wire.

"I couldn't lean how to use the [old] equipment, so I replaced it."

Rich Epstein, '82,
former business manager.
The Tech

"To put out a newspaper" at *The Tech* implies production as well as print. Like the rest of M.I.T., we like to do all the engineering ourselves on the latest computer equipment, and we take to heart 2.70 Professor Woodie Flower's admonition to "make it look good." This interest in design affects the management of the paper: print and production are equal partners and staffers commonly work both sides of the office; most newswriters learn simple production work, and most of the production staff members have written for the paper.

The Tech has gone through 15 redesigns in its 104-year history, and four generations of typesetting technology in the last 20 years. In 1964, we became one of the first college newspapers to go from linotyping at the printer's to setting our own "cold type." We used IBM Selectric composers—typewriters that automatically printed the text "justified," with straight margins both sides. In 1972, we got a brace of Pacesetter photocomposition machines, and a few years later, a desk-sized word processor to go with them.

The volume of recruiting ads from high-tech companies has increased steadily since 1975. This allows *The Tech* to support itself and upgrade its equipment entirely from advertising, subscriptions, and outside typesetting jobs done in our production shop by paid staff. The five-cents-a-copy charge disappeared in 1975 and the newspaper is now distributed free to ("dumped in large bundles at") campus buildings.

We changed typesetting technology again a few years ago, but no one noticed except the staffers who got to bed at 3 a.m. instead of 5 a.m. because of it. The new *Tech* Electronic Newsroom (TEN) is a $130,000 computerized editing, composing, and typesetting system that many city dailies would love to have. *The Tech* is the only college paper we know of that can typeset and compose a whole page at a time, and many of its formats and graphics tricks are home grown. "We may not have the best equipment, but we have the best hackers," says former managing editor V. Michael Bove, '83.

The extra recruiting ads drive up the issue size, but they make putting the issue together easier. Five years ago, three night editors were required to supervise the pasteup of a 16-page issue, and they would be warned not to take classes that met on Thursday, because they could expect to spend all day in the production shop working on the Friday issue. Last term, a single editor pulled off a 32-page issue—the largest ever—including a special quarterly "places-to-go, things-to-do" section.

"When we first got the Pacesetters in 1975, we had a special glass phototypesetting disk made," said former night editor Bill Coderre, '85. "We ordered our text and headline typefaces put on it, and we still had lots of space left over. We put accents and umlauts and other things from foreign alphabets, and we still had space left over. We put in every mathematical symbol we could think of, and we still had space left over. We put in almost-obsolete printer's characters like the section mark and the new-paragraph mark, and we still had one space left. It seemed a shame to waste it, so we picked the turkey."

The turkey has become the symbol of *The Tech*. It has been used in movie reviews in place of stars (five turkeys was the lowest rating and no turkey was the highest), stuck over company logos on the typesetting equipment, and carved in ice for the 100th anniversary banquet.

Some of our readers think the turkey symbol is cute, some don't notice it, and some think it describes us perfectly.

"The first hundred years were just for practice."

Motto, *The Tech*
Volume 101

Simply being the first newspaper and having first crack at the small pool of students who want to spend time on a newspaper is one of the reasons *The Tech* has survived to be the only regular student newspaper.

Sad but true, *thursday*, the radical '60's alternative newspaper, folded in 1979—the cover of the last issue read, "Pigs bust *thursday*," although their equipment was confiscated not for insubordination but as payment for debts. *Link* was a newspaper that had no philosophy except "Don't believe everything you read and don't let anyone tell you what to think," according to Z Smith, '81, one of its staffers (*Link* had no editors). It lasted for only three years in the early '80s.

Sad but true, M.I.T. is a one-newspaper town these days. This means we don't have to compete with the other guys for staff, coverage, or readership. There are no other guys. This leads to a certain lack of urgency and venom, which leads to complacency.

Sad but true. We are the M.I.T. newspaper of record. We are also the only M.I.T. student newspaper to use standard journalism techniques; we teach our reporters to write in the traditional inverted-pyramid fashion, to follow "*Tech* style" on questions of punctuation and usage, and to edit themselves and others. In consequence, our readers often see us as monolithic, conservative, and self-important. Sometimes we are. Sometimes we can't help it; if we turned into an underground newspaper tomorrow, there would be no one left to report faculty and student government meetings. Sometimes we aren't. Then, we muckrake and hold editorial board meetings that resemble limited nuclear war (when we are not embarrassing secretaries of state).

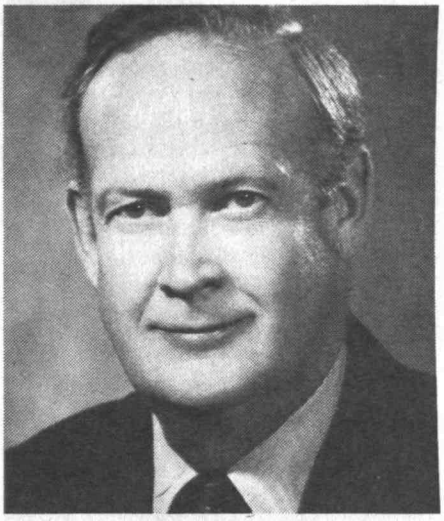
Nobody comes to M.I.T. to learn to put out a newspaper. But maybe they should. □

Officer Announcements, Drama Celebrations, and Welcoming Seniors Into the Fold

New Leadership Prepares To Take Office

E. Milton Bevington, '49, will serve as president of the M.I.T. Alumni Association (AA) for 1985-1986. He heads a roster of luminaries which includes Richard A. Jacobs, '56, as vice-president, and Michael M. Koerner, '49, Christian J. Matthew, '43, and Robert Swanson, '69 as AA nominees to the Corporation. (Emily V. Wade, '45, was also named V.P.; her photograph and biographical material will appear in the next edition of *Technology Review*.)

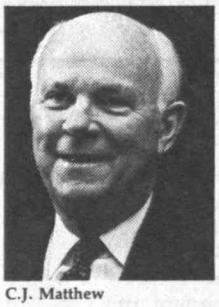
The new officers were announced by Joe F. Moore, chairman of the National Selection Committee.



E.M. Bevington

R.A. Jacobs

M.M. Koerner



C.J. Matthew

R. Swanson

While an undergraduate in chemical engineering, **Milton Bevington** was active in student government and a member of Sigma Alpha Epsilon fraternity. After receiving the M.B.A. from Harvard, he held posts with Dewey & Almy (now part of W.R. Grace), Westinghouse, and The Trane Co. In 1974, he formed Servidyne, Inc. in Atlanta, a company specializing in products and services related to the operation of building systems. The company now has offices in eight U.S. cities and does business worldwide. Bevington's years of activity in the AA, which earned him a Bronze Beaver in 1984, included substantial efforts in fund raising. He is on a number of community boards, and currently chairs the Atlanta chapter of American Humanics, a national group dedicated to training professional leadership for youth agencies.

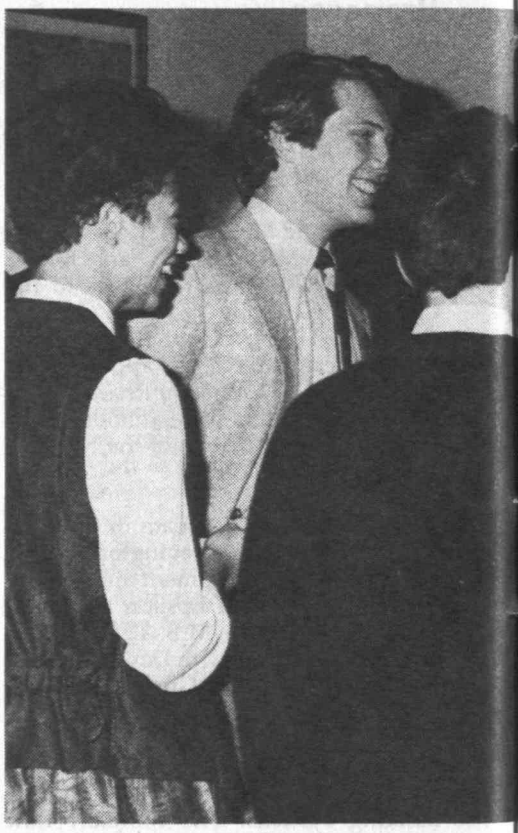
Richard A. Jacobs, '56, graduated in management, and he held manufacturing and engineering management posts with Questor, Champion International, and Mobil Chemical before joining A.T. Kearney in 1966. He is responsible for the Systems and Manufacturing Operations Practice for Kearney, which is a management consulting firm. Jacobs is a 10-year Club Board member and past president of the M.I.T. Club of Chicago, where he was active in fund raising and educational efforts. He has been a director of the AA, and filled an unexpired term as V.P. before being named to a full term.

Michael M. Koerner, '49, took an undergraduate management degree at M.I.T. and an M.B.A. at Harvard. He recently stepped down from chairman to deputy chairman of Suncor, one of Canada's major integrated oil companies. Since 1959, he has also run his own business, Canada Overseas Investments Ltd., which focuses on venture financing on both sides of the 49th parallel. Koerner was awarded a Bronze Beaver in 1981, having served in various fund raising capacities, Corporation committees, and as director and president of the M.I.T. Club of Ontario. He is also vice-chairman of the Board of Governors of York University and is on the executive committee of the Art Gallery of Ontario. Koerner has been honored with the Order of Canada.

Christian J. Matthew, '43, joined Arthur D. Little in 1943, after earning a degree in chemical engineering. In 1954, he established the firm's Western Division, and he managed it until 1963. After four years as president of a company which manufactured instruments for clinical and chemical laboratories, Matthew became the associate administrator and director of planning for St. Mary's Hospital and Medical Center in San Francisco. He was responsible for planning and construction for a $35 million, 555-bed community teaching hospital. He is now executive V.P. of St. Mary's Foundation, a private fund-raising organization affiliated with the hospital and other nonprofit services. Recipient of the Bronze Beaver in 1977, Matthew is a member of the Corporation Development Committee, the Educational Council, and the M.I.T. Club of Northern California. He is active with his class and the AA, and has held several major posts with the Alumni Fund.

Robert Swanson, '69, holds a bachelor's degree in chemistry and a master's degree from Sloan. The founder (with Herbert Boyer) of Genentech, he is presently president of the company. He has also been a partner with the Kleiner & Perkins venture capital partnership and a Citicorp investment officer. He served several terms as an officer of the M.I.T. Club of California and on Corporation Development and Visiting Committees.

In record numbers, seniors accepted the invitation of President Paul E. Gray, '54, (far right in center photo) and Priscilla Gray to a series of Senior Dinners during winter term. The dinners welcomed the Class of '85 into the M.I.T. Alumni Association. Seniors discussed their post-graduation plans (photo far right); and alumni like Regina Herzlinger, '65 (below), a faculty member at the Harvard Business School and member of AA and Corporation committees, talked about their involvement with the Institute.



Not an Unknown

TO THE EDITOR:

The "unidentified alumnus" on p. A6 of the January, 1985 article on the National Alumni Conference (NAC) is Barry Bronfin, '60, chairman of the Class of 1960 Reunion Gift Committee. A resident of Connecticut, Barry went to Dallas to meet with committee members Gordon Moore, William Nicholson, John Norris, Erik Ringkjob, and Tom Thiele. They planned strategy for raising the Class of 1960 Endowment for Innovation in Education. President Gray has characterized the fund as a needed pool of "venture capital" for supporting new approaches in curricula at M.I.T.

Neil Didriksen
M.I.T. Alumni Center

Shirley Picardi, Ph.D.'72, honorary member of the Class of '28 who was also a Sloan Fellow, recently stepped down as secretary of the Alumni Association to take up the post of M.I.T. bursar.

Shakespeare Ensemble Tours California

The M.I.T. Shakespeare Ensemble mounted "Twelfth Night" for its 10th anniversary tour in January. The troupe was hosted by alumni clubs and the families of present and former ensemble members up and down the California coast. They visited Stanford, Monterey, Oakland, Santa Barbara, San Diego and Los Angeles, and had the satisfaction of hitting the "playing rhythm" director Derek Campbell was striving for in the performance at Cal Tech. They enjoyed warm hospitality, but Mrs. Coyle's efforts (successful) to help Eric Ristad, '85, complete grad school applications, and the Holleys' Hungarian stuffed peppers earned special mention.

Scott Pollack, '86 (right) Shakespeare Ensemble tour photographer, got this shot as he and Brian Latt, '86, waited to go on.

PHOTOS: FRANK REVI, '86, SCOTT POLLACK, '86

When the late Joe Everingham left a post at Harvard to become director of drama at M.I.T. in 1954-55, the same year that Kresge and the Little Theater were opened, it was the beginning of a new era at M.I.T. Some 100 alumni and friends of Dramashop gathered at the M.I.T. Museum in February to celebrate 30 years of dedication to high standards of theater performance by Everingham and his successors, and the role Dramashop played in their educations and their lives. (Near right) Sloan faculty member and Dramashop alumnus Jeffrey Meldman, '65, joins Robert Scanlan, '70 (standing) director of Dramashop, in a salute. (Far right) It is safe to assume that David Altshuler, '86, fresh from his triumph in the spring production of "Keep an Eye on Amelie," is making an even more lighthearted toast, which is enjoyed by his father, faculty member Alan Altshuler.

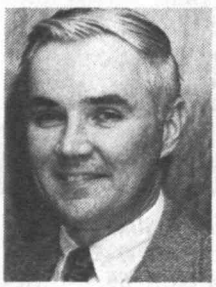
1984 Lobdell Awards Presented to Four

Harold E. Lobdell Distinguished Service Awards for 1984 were presented to four Alumni at winter meetings of the Alumni Council and the Alumni Fund Board in Cambridge.

Edwin F. Brush, '63, was honored for his leadership of the Alumni Fund Personal Solicitation Program in Boston, as well as contributions on the Alumni Fund Board and the Alumni Council. **Vincent A. Fulmer**, S.M. '53, secretary of the Institute, was honored for his efforts on behalf of alumni, in particular his support for M.I.T. Enterprise Forum. **David R. Wadleigh**, '38, received the Lobdell for his tireless, energetic support of the M.I.T. Club of Cape Cod, his class, and the AA. **Sandra G. Yulke**, '74, was honored for her work with the Educational Council, her class, AMITA, and the Alumni Fund.

V.A. Fulmer

S.G. Yulke



E.F. Brush

D.R. Wadleigh

If You Missed I.M. Pei, All Is Not Lost

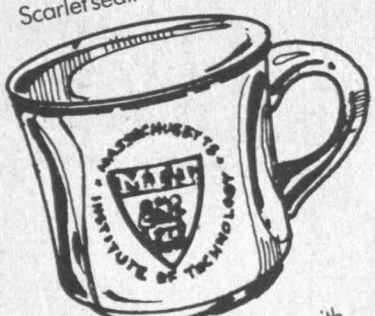
On March 1, a day dedicated to celebrating the arts (see p. A16) I.M. Pei, '40, gave a lecture on the development of architecture over the years of his career, from both a historical and a personal perspective. He remembers the 1937 visit of Le Corbusier to Cambridge as "the two most important days of my professional life." The great European architect was "insolent and abusive," Pei said, "but he did everything right—shocking us out of our complacency." Pei's lecture was followed by the opening of an exhibition of his work, which ranges from his student drawings to a model of a project not yet underway. The exhibition will be in the Compton Gallery until April 27, then reopens in the M.I.T. Museum in June. The Museum is selling tape recordings of the Pei lecture, and plans to produce a videotape.

What better time for M.I.T. insignia

■ Glass Beer Mug with platinum M.I.T. insignia seal. **$6**

■ Solid Brass Paperweight with M.I.T. Seal engraved. **$15**

■ Ceramic Piggy Bank. Creamy white with gold trim ears and hooves. Scarlet seal. **$12.95**



■ Ceramic Coffee Cup with tri-color insignia seal. **$5.95**

▲ Hooded Insignia Sweatshirt. Scarlet seal on grey or white seal on scarlet. S–XL in a cotton/poly fleece. **$20**

▲ T-Shirt with scarlet M.I.T. letters and seal. Contrasting band on neck and sleeve. Cotton/poly blend. S–XL. White only. **$8**

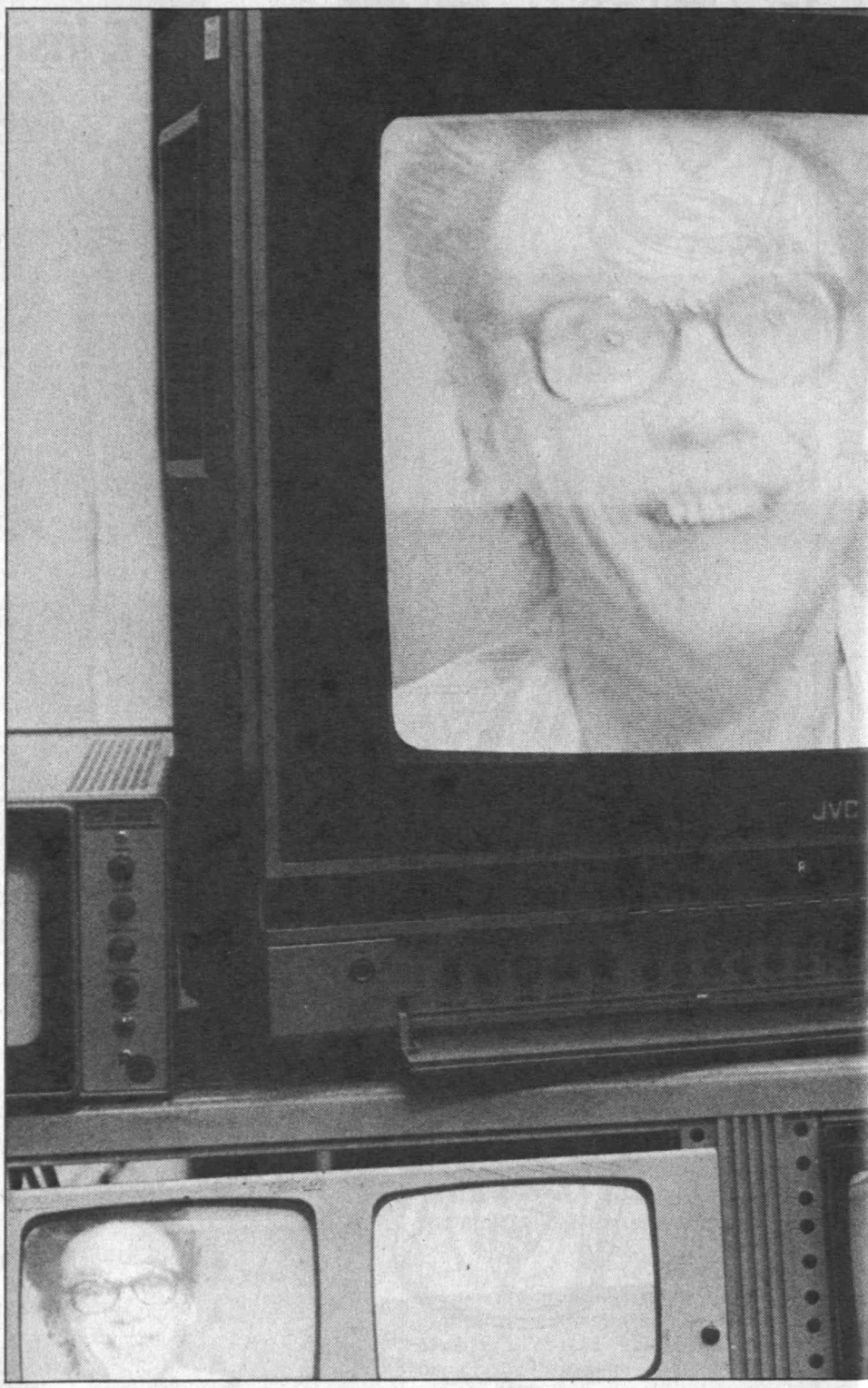
■ Not Shown: T-Shirt with new M.I.T. logo on left chest. 100% cotton. S–XL. Maroon only. **$8**
White with M.I.T. block letters, front only. Crewneck with insignia seal on front. Grey, maroon or white. **$16**

HARVARD COOPERATIVE SOCIETY **the Coop**

Available at M.I.T. Student Center. Coop Charge, Mastercard, Visa and American Express welcome.
Call toll free: 1-800-792-5170 within Mass., 1-800-343-5570 outside Mass. Tech Coop open Mon.–Sat. 9:15 to 5:30pm.

PROFILE

Physics, with Love, from Lewin



His appearance is a political cartoonist's dream: a shock of light brown hair stands straight up from an animated face. Shaggy eyebrows compete for space with dark-framed glasses. He carves the air in front of him with long, slender hands, his fluid gestures adding emphasis to rapid, Dutch-accented speech that scarcely seems to leave him time to breathe. His lectures elicit applause, even cheers, and students who have long since completed the subject watch his cable TV help sessions for the joy of it. His tall, painfully-thin frame, probably just the result of genetics, makes it easy to imagine that he is burning himself up with the intensity of his teaching.

The lecturer is Walter Lewin and the subject is 8.02, Introduction to Electricity and Magnetism.

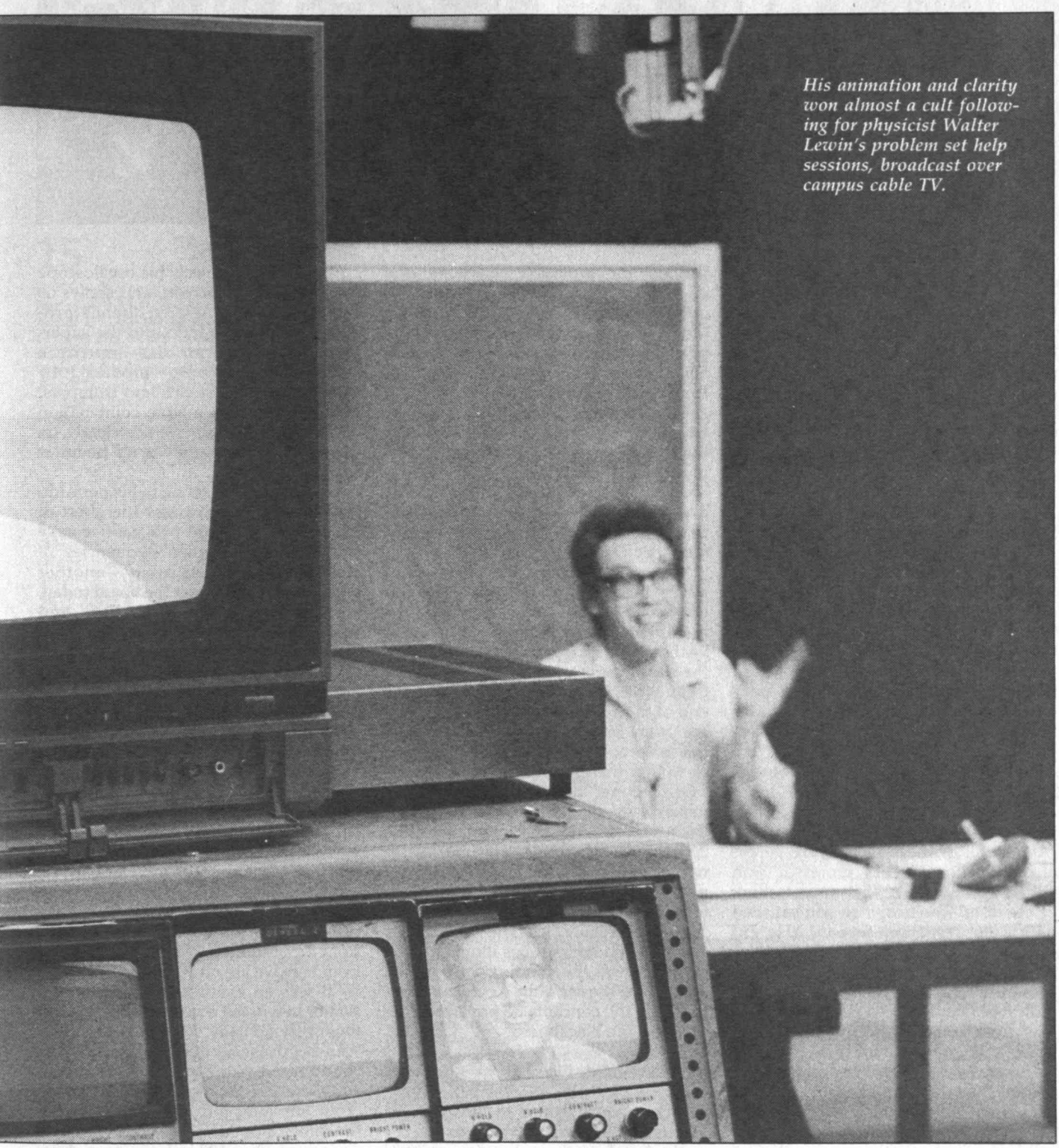
A pioneer in x-ray astronomy and member of the M.I.T. faculty since 1966, Lewin's achievements as a teacher and researcher earned him a current senior U.S. scientist award from the Alexander von Humboldt-Stiftung, a major research center in the Federal Republic of Germany, where he is spending this calendar year. But when he taught 8.02 in the second term of 1984, he devoted a work-week of more than 70 hours entirely to that subject, putting in approximately 20 hours of preparation for each pair of lectures (delivered back to back to accommodate the numbers.)

His imagery when he talks about the class is illuminating. He refers to room 26-100 as "the arena," where he faces as many as 700 students in the course of two lectures. "There is an electricity between you and the audience," he says. . . . . "I can make it so quiet, you can hear them breathe. . . . Teaching recitations with 20 to 30 students, you don't have that champagne in your blood."

Walter Lewin is a man who experiences enviable job satisfaction. "Lecturing," he says, "is like falling in love."

And his students are swept along. In 1984, the Science Council gave Lewin one of its two $5,000 prizes for excellence in undergraduate teaching, commenting that his "careful, imaginative preparation and ebullient delivery have made an enormous impression on one of the Institute's largest and most difficult audiences. The ability to deliver the same lecture twice in the same day and maintain any enthusiasm is extraordinary," the council citation went on. "Reports from students, substantiated by our own observations, are that the 11 o'clock lecture is, if anything, superior to the 10 a.m. version."

Like all members of the physics de-



His animation and clarity won almost a cult following for physicist Walter Lewin's problem set help sessions, broadcast over campus cable TV.

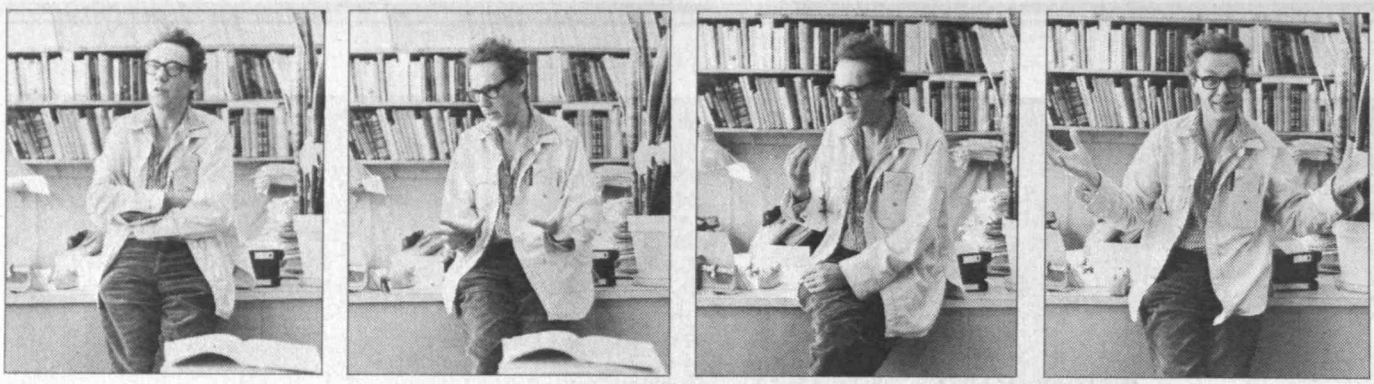
partment, Lewin taught recitation sections of 8.02 for years. He wouldn't have considered taking on the large lectures without that experience.

He works on several lectures at once, spending 10 to 15 hours just thinking about what to do, what he calls designing the "architecture of the lecture." Then he starts a series of dry runs in his office, putting time marks at every three-minute point on the script, so that he will be able to monitor his final presentation with a stop watch.

At first, the lectures are inevitably too long, and he "does surgery on them," creating short, optional buffer units which can be dropped in or omitted to fit the time-slot precisely.

Taking time out for little else but walking for miles on the beaches of Plum Island, winter and spring, he continues the process of constructing his 36 lectures. (There are actually 37 lectures for 8.02, Lewin explains, but he arranged months in advance for a colleague to give lecture 16, while he was out of town chairing a meeting of the NASA Balloon

PHOTOS: FRANK REVI '86



Working Group.)

Once in the lecture hall, he runs on "the champagne in the blood" for hours. As soon as the two lectures are over, he listens to the tapes, checking for lack of clarity, which he regards as the ultimate offence. He grades each performance, striving for ruthless objectivity. (He's considering repeating 8.02 in 1987, but will have to decide if he's up to it.)

Spreading the Gold Around

Lewin certainly did not absorb his inspired teaching methods from his mentors at the University of Delft, where he took the Ph.D. "In Holland the faculty are lousy lecturers," he says bluntly, describing the attitude as "I am Herr Doktor Professor, and I will spread the (intellectual) gold around." He started teaching in a high school while a graduate student, and believes, quite frankly, that he has a real talent for lecturing.

But he is always concerned about his audience. Four weeks into the term, Lewin gives the students a questionaire. How are the lectures? The homework? (Almost all of the problems are generated by fellow-physics professor Stan Olbert and Lewin.) What do you think of the tests? The text? Are you satisfied with your recitation section? (He encourages students to switch recitations if they are not comfortable with their present instructor.) When the students indicated that the rapid pace of the class was their major concern, he slowed down "20 percent, for one lecture." Their anxiety relieved and confidence restored, he resumed his pace. The students kept up. (There is no charge for the psychology lesson.)

Bonnie Derman, then a fourth-year physics major visiting Lewin's lectures at the urging of a friend, was inspired to tackle the daunting task of describing 8.02 a la Lewin for her science writing program. She gives the flavor of the class in the paragraphs that follow:

"The lecture I attend is virtually flawless, flowing smoothly from a graphic display of the motion of a line to a propagating sinusoidal curve, through the applicable equations, and on to standing waves and resonance frequencies. We discover with Professor Lewin how to find the wavelength, amplitude, and period of the wave from its equations, and are prepared to progress from today's visible waves in ropes and springs to the next lecture's topic: electromagnetic waves. The equations and their relationships to wavelength, amplitude, and period will be identical, allowing a direct link between our everyday picture of physical wave motion and the new concept of electromagnetic waves.

"Lewin turns now to his large lecture table, littered with a curious conglomeration of springs, strings, woodwind instruments, and other paraphernalia. With a long spring and a student from the class to assist, he displays resonance frequencies by manually pumping his end of the spring up and down, and we see from his exertion that the spring doesn't want to vibrate at any frequencies other than resonance. He finds the first, second, third harmonics—then makes a frenzied attempt to go higher: 'I counted 27' he exclaims, 'that's the 26th harmonic, right?' His gleeful innocence is greeted by laughter and applause from the students. He proceeds to a motor that drives a string at various resonance frequencies. The lights dim as two independent strobes illuminate the string to show the standing waves in red and green. We see quite clearly and dramatically the concepts he previously derived on the blackboard.

Reinforcement, Phase II

"Plucking on a guitar to illustrate his discussion, Lewin reveals to us the methods of violin-maker, tuner, and player, which we now understand in the context of our equations of wave mechanics. He plays 'Jingle Bells' (rather poorly) on a wooden trombone, showing us the change in resonance frequency with the change in length of the instrument. Phase 2 of reinforcement is greeted with more applause. This learning is not only painless, it's fun.

"Lewin then projects his oscilloscope output onto a TV screen, and shows us the essentially single frequency produced by a tuning fork, and the superposition of harmonics—multiple resonance frequencies—produced by students on their violins and trumpets. Each instrument's unique combination of harmonics, which we see clearly on the screen, accounts for its peculiar sound, he tells us.

"As a dramatic closing to his performance, Lewis demonstrates the effect of the molecular weight of a gas—usually air—on the resonance frequencies of sound from a given cavity—another equation we've seen on the board today. He fills his lungs with helium and squeaks like a Munchkin from the Land of Oz for a moment before dismissing the class. Phase 3 of concept reinforcement nearly causes him to faint", but his points, as usual, are crystal clear.

"Your Life Will Never Be the Same"

"On April 9, 1984, freshmen roamed the halls of M.I.T. carrying daffodils. They had just seen the complete set of Maxwell's equations and understood them for the very first time," Derman reported. ("This is the main objective of 8.02," Lewin told the class, "we have completed a long journey. The view from the summit may still be foggy, but from here we are only climbing down.")

"It was an event so momentus that Walter Lewin felt a need to congratulate them ceremonially," Derman reported. "As he presented the flowers, surrounded by huge projections of the equations on the walls, he told them: 'Your life, after this date, will never be the same . . . you've lost your virginity. Congratulations.' The cheers were deafening.

"After the class I attended, several students from a fraternity invite him to dinner at their house. That makes the ninth such invitation this month, Lewin remarks. By way of explaining his success, he says, 'I expose them to their own world and show them that the physics is all around them, and that it is beautiful.' " *Susan Lewis* □

15 70th Reunion

Hi '15ers. Spring is once more here, and **Loring Hall** is on the job, with the following notes:
August 17, 1913: My 20th birthday. Received lots of letters and several boxes of goodies, which were soon devoured. Five of us went over to Chase's Mills to visit with **Francis Dana,** "the gented Indian." He is a full blooded Passamaquoddy Indian and famous around here for his wisdom.
August 20, 1913: A long tiring day of plane table work, from Bennis Hall to the top of the bluff, laying in two-foot countours. As we worked we ate our fill of the large wild blueberries that grow here in great profusion. They were luscious.
August 20, 1913: Worked on railroad curves under Professor Allen. There were clouds of pesky black flies that drove us to desperation. Professor Hosmer talked after supper on "triangulation."
August 23, 1913: **Harvey Daniels** and I walked around the lake and to E. Machias, about ten miles. We each bought a pair of moccasins with taps for $2.50 and did some errands for Howard and Hoyt.
August 24, 1913: After breakfast, **John Gallagher, Joe Livermore,** and I took a long walk toward Dennysville and came back through the woods. Ran into a swamp and had an exciting time getting through it. Almost got mired. Had a fine chicken dinner. Dr. Robinson lectured on first aid.
August 25, 1913: Still at M.I.T. Surveying Camp, Gardner's Lake, Maine. Did some triangulation work this morning. Had to walk two miles with the transit "gun" but **A.J. Caffrey** carried it back. After supper **Seward Highby** showed me how to play chess. Found it very interesting. Shall read up on it.
August 26, 1913: Spent the entire day near the Jacksonville Road taking topography with a plane-table under Professor Hosmer's direction. **Frank Scully** and **Ted Friebus** were in the party. Played chess with **Curtis,** but he beat me easily.
August 31, 1913: Professor H.W. Smith gave an illustrated lecture on his adventures among the head-hunters of Borneo.
September 1, 1913: Labor Day—a gala occasion, with several hundred visitors, including some pretty girls, which are very scarce in these parts. In the morning we had all kinds of sports. The most exciting was the "Hurry-Scurry Race," in which **Wardwell** got second place. The overall prize was won by **A.B. Curtis,** with 18½ points. **Ted Friebus** was a close second with 18. After lunch there was a dance in the drafting room. **Jack Dalton** and **Ted Friebus** fell for the same girl, which provided a lot of amusement for the rest of us.
September 3, 1913: Worked all day with **Lloyd Chellman** on a survey at Chase's Mills. It was hard work.
September 4, 1913: Had a dress rehearsal of the minstrel show that is to be given at E. Machias on Saturday night. **Ralph Malcolm** and **Waldo Pike** were the stars.
September 7, 1913: It was **Ed Bascom**'s birthday. We enjoyed sharing birthday cake after dinner. Our Sunday evening lecture was by Professor Sedgewick, subject: "The Balkan Wars."
September 8, 1913: Played chess all evening with **Millard Pinkham**. We each won one game. The more I play chess the better I like it.
Setember 12, 1913: Had field work under Professor Allen, laying out railroad curves and found it very interesting.
September 13, 1913: Started off with an exam in hydraulic measurements. It wasn't too hard. After lunch **Dick Hefler** and I started walking in the rain to Machias, where we watched the operation of a large sawmill. Stopped in at a dance organized by **Virgil Wardwell**. He introduced his girlfriend, Julia Bowker, and her mother. After a steak dinner at "Dan's Place," bought some heavy duty dry sox. Attended the movies, went to another dance, and finally wound up at the camp at 2 a.m. Quite a day.
September 14, 1913: Spent another hard day surveying with the heavy transit. It was through dense underbrush, and I swung a brush hook until my hands were blistered. **Bill Jennings** and **Viking Enebuske** worked with me. Found an ancient grave in the thickest part of the woods. It was marked "Owen Dowling, age 3 years."
September 20, 1913: Left at 8 a.m. with Professor Robins and **Wardwell** in the power boat for Upper Lake, where we worked all day along the shoreline. It was the most exhausting work I ever did, and I could hardly move when I got back to camp. We covered about five miles of shoreline.
September 23, 1913: It stormed so hard last night that nobody got much sleep. Our tent jumped up and down like mad. Left in the pouring rain in a dinky old-fashioned stagecoach. Finally got to Bangor and took the *S.S. Belfast* for Boston. **Highley, Hefler, Stone,** and **Bagdoyan** took the same boat. Sailed down the Penobscot River, stopping at Searsport, Bucksport, Belfast, and Rockland. It was a lovely ride and we enjoyed every minute of it. After supper we sang songs on deck before turning it.
September 23, 1913: Woke up in Boston Harbor at 6:30. Took **Dick Hefler** home to Dorchester with me. Was glad to be home after seven strenuous weeks, but I wouldn't have missed the experience for the world.

Fifteeners, Technology Day is Friday, June 7, 1985. Are there some of you who would like to seriously consider getting together for the event? Please let me know.—**Joyce Brado,** Acting Secretary, 491 Davison Rd., Apt. 9, Lockport, NY 14094

16

Everbody must have writer's cramp. No letters. Made a few phone calls. Couldn't talk with **Nat Warshaw** because he has moved to a retirement home in another section of Sarasota, Fla., and I couldn't get the name of the home. . . . **Shatswell Ober** was at home in Arlington, Mass., when I called. He was getting ready to go out to do his shopping. He doesn't have any news to report, but says that he is fine. . . . I tried to reach **Charlie Reed**, but he and Millie had been out since early morning and weren't expected back until evening. Left word for them to write me a newsy letter. When I called **Doug Robertson** in Taunton, Mass., he was resting, so I didn't bother him but learned that he is feeling fine and goes walking almost every day. . . . **George Crowell** answered the phone in his office and confirmed that he goes to his place of business shortly after 7 a.m. almost every day and works a good part of each day. . . . **Charlie McCarthy** sounded great and said that he was feeling fine. He did allow that he has had to give up driving at night, but that he has a 92-year-old neighbor who does the driving when Charlie has to go out at night.

I enjoy the pleasure of talking with '16ers on the phone; but as you can see, I don't always get through. I tried a couple of times to reach **Dina Coleman** but no answer. Please write so that we can share your news with other classmates. One message that comes through strongly in all my telephone contacts is the interest and concern that each classmate has for the others and the continuing good feeling which flows from the memories of the good times shared. Keep eating, drinking, walking, breathing—everything in moderation.—**Bob O'Brien,** Acting Secretary, H. E. Fletcher Co., Groton Rd., W. Chelmsford, MA 01863, (617) 251-4031

18

Henry Stephens is still living the ideal life, as you will realize: "Judith and I find life at Waikiki a continuous delight. The ocean water stays comfortably warm the year-round, and we swim morning and evening at a beautiful sandy beach three blocks away. In addition, we vigorously participate with an exercise class of 30 to 200 people on a palm-shaded grassy area next to the beach starting at 9 a.m. each weekday. There are many large beautiful hotels nearby which have dances and good buffets that attract great crowds of visitors. The food is wonderful, even if expensive. Occasionally Judith suffers from claustrophobia (island fever), but this is readily cured by trips to other islands or to California, New Zealand, Tahiti, etc., and we are always happy to get back home. Wish you could join us here for a vacation sometime."

Last June Eunice and **Ted Braaten** celebrated their 64th anniversary and Ted's 90th birthday at a big party in New Jersey, about halfway between Chappaqua, N.Y. (where his older son lives) and Washingtion, D.C. (where his other son works). Ted says, "My brother's widow (also 90) and all the children and grandchildren had a great time getting acquainted. We have given up traveling. We are in good health and enjoy living in our one-floor house on a beautiful street with 13 friendly families. We are looking forward to our 70th reunion, and I hope you will be in charge."

Bill Collins writes to explain his delay in responding to my season's greetings. Two years ago he was stricken with a virus which attacks the nerves and muscles. After five months of hospitalization and five more of therapy in a rest

home, he returned to his mobile home. He says, "In spite of my crippled state, I have attended weddings of two of my grandchildren, and later next month a third in Texas with the help of my offspring. I have decided to let someone else scheme to run the world, and at nearly 90 years, enjoy whatever occurs in the future." For all of us '18ers, our best wishes for your improved health—and a salute to you for your fighting spirit.

Eaton Clogher writes: "I do little traveling these days. Car travel is restricted to 50 miles a day and a maximum of one such trip a month. I use a car every day for short trips and average about six miles a day. I spent five days in Yale New Haven Hospital back in May under protest—they stuck a pacemaker in me. My eldest granddaughter is now at American University in Washington, D.C. After a master's degree in physics, she intends to go for a doctorate. Had she gone to M.I.T., she would have been the fourth Clogher to attend. The first graduated in 1893, my youngest daughter in 1963 (five years with a BAR in architecture), and of course my four years. The only Clogher grandson I have is 11 years old. Maybe he might go to M.I.T." Let us hope we can correspond a year from now in reasonable mutual good health.—**Max Seltzer,** Secretary, 1443 Beacon St., Brookline, MA 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Apt. 15, Brookline, MA 02146

19

M.I.T. will be buzzing soon with Technology Day 1985 events. We hope that the Class of 1919 will have some representatives there and that your secretary will receive a few notes for our *Review* column. Anyhow one of the five years leading to our 70 year Reunion will have passed leaving only four to go.

In the absence of notes for this issue, we did some telephone calling. Had a nice talk with **Bill Vogt** up in Rochester and found him recovering from a cold but otherwise well and active despite a tough winter with 80 inches of snow.

We missed our annual postcard from Barbara and **Don Way** from their Florida vacation. We found the reason: they slipped on some ice and Barbara required a cast, so their trip was cancelled. Don has trouble reading but has found a solution—his public library in Westfield furnishes cassettes prepared from a library of books. A good idea, Don; others may be interested.

A call to **Audry Ames** in San Francisco was enjoyed. Audry was at home and feeling fine. He is now 90 years old. We talked about the 65-year reunion and several members of our class such as **Chuck Drew** and **Larry Riegel**.

Word has just reached us of the death two years ago of **George H. Wiswall**. All we know at this time is that he resided in Edgartown, Mass. Any reader knowing more please advise.

Now do have a good summer and tell me something about how you are and what you are doing.—**W.O. Langille,** Secretary, Box 144, Gladstone, NJ 07934, (201) 234-0690

20 65th Reunion

Henry Hills writes that he and Mary are enjoying their winter at La Jolla, Calif. and intends to spend the summer in Melrose. They toured England and Scotland and had a delightful time. . . . **Bill Dewey** now lives in a retirement home with his wife Barbara at 10950 Temple Terrace, Seminole, FL 33542. Bill gets around well, has frequent visits from his family, and now has five grandchildren including twin boys. Good for you, Bill. . . . **Ross Nebolsine** of 64 E. 86th St., New York City writes that he remains active, working on several projects. As a civil engineer he began his career as a designer with the Emergency Fleet Corp. Then he worked as assistant engineer on the construction of the Shelton Hotel in New York, and on hydro-electric projects for Electric Bond and Share Co. He was in charge of the development of water supply for Lisbon, Portugal, and the London Metropolitan Water Board, then assisted with the construction of the Grand Coulee and other dams. He served as president of the Hydro-technic Corp., designers of various water supply and waste treatment projects. Ross is married and has three children. He certainly has had a distinguished and useful career. More power to him! . . . A word from **Jack Nolen,** who admits that he expects to be a great grandfather before reunion time. . . . And another from **Elbridge Wason,** who says he attends the Newton retired men's club and sees **Phil Wait** and **Al Burke** at these meetings.

Responses, thus far, from the reunion questionnaire indicate a promising attendance at the reunion. Twenty-three classmates have indicated interest, and some will bring wives, sons, or daughters. A report will appear in the next issue. A note from the daughter of **Joseph N. Wiegand** of 865 Longridge Rd., Oakland, Calif. tells of his death on January 9 of this year. She expresses appreciation for keeping her father informed all these years of the class activities.—**Harold Bugbee,** Secretary, Apt. 702, Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

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Here we are, only a year to our 65th reunion. How many of us get there will depend largely on health and to some extent on distance from Cambridge. At this time we can see that our reunion gift to M.I.T. will be substantial. . . . Marion (Mrs. **George) Chutter** had health problems and one bout of surgery in 1984. She was using a four-pointed cane to get around but is likely off it now. She drives her car for short distances. **Bob Miller** phoned her when he was on the Cape, and Marion mentioned how much she missed Helen Miller, "a beautiful person." . . . Helen (Mrs. **Raymond) St. Laurent** remarked on how difficult it must have been for your secretary to give up his home and move to Albany. Helen returned from Center Lovell, Maine to Manchester, Conn. last November 2, and was busy getting ready for Christmas at that time. . . . Millie and **Herb Kaufman** write, "We are missing you and Betty [Hayward] this year, but this is the way life turns as we get older. We are grateful for the years we had together." . . . Emma (Mrs. **Leon) Lloyd** reported an active year (1984): "Between my hospital volunteering, chairperson of the music committee at church, treasurer of the Westerly College Club, and our Garden Club, I keep busy. However, I always find time for a game of bridge. Al and I used to play a game called 'Spite and Malice' each day after lunch. In September and October I was in Greece, first in Athens and then on a five-day 'Classical Tour' to Corinth, Epidermus, Olympia, and Delphi. This was followed by a week's cruise of the Greek Islands and a visit to Istanbul. My oldest granddaughter, who is getting her master's at Westminster Choir College gave a Thanksgiving Eve voice recital."

Elliott Roberts writes from Bethesda, Md.: "My wife Becky and I are now in our mid-80s and life for us is due for a major change. I have been retired since 1962 and have kept busy with committee work, biographical writing on club members, and other affairs of the Cosmos Club. There I have been associated with numerous M.I.T. men, including among others **Dick Smith** and **Jim Cudworth**. We are awaiting a vacancy at a retirement home in McLean, Va. It will be a hard task breaking up our lovely home of over 40 years and condensing into small quarters." . . . **Harry Butters** of N. Quincy, Mass. still swims a lot, generally using the Harvard pool that has a three-meter diving board compared to M.I.T.'s one-meter diving board. Harry reports no aches or pains and no aspirin for several years. Says he, "Hopes you are well, and that we'll meet at the 1986 reunion."

A note received from Velma (Mrs. **Sanford) Hill** around Thanksgiving time was full of recollections. "You may not remember that Sanford and I spent Thanksgiving at your house before we were married. I think you were with us at Denbigh Hall, Wilmington one year and when your daughter Priscilla was at Swarthmore, I think we had one or two dinners together. I am very pleased that I feel well enough this year to have the family at my house. There will be five of us here—small company compared to a friend who will have 26. We have not yet seen any snow but it was 17o here this morning. I am pleased you and Betty were able to celebrate your 60th anniversary together."

Jim Parsons was shocked at our having to move to Albany. He writes, "I spent two years at Union College in Schenectady before transfering to M.I.T. so am fairly familiar with that country. I still miss the colors of the mountains around October 1. There is some color around here but nothing to compare to New York and New England. A couple of weeks ago I was invited to a symposium given by M.I.T. to interest prospective students. I have a step-grandson who will be 16 in two weeks, and I'm working on him. He is number 1 scholastically in his class. He should be sure fire at the Institute. The next time I get to Albany, I'll look you up."

Ceil (Mrs. **Frank) Huggins** wrote her usual entertaining Christmas letter, complete with miniature drawings of alligators. She said, "Last winter I took another art course here in the village. I still am most interested in my trail guiding in the nature center on Sanibel. Some of the people I meet know more about the places in Florida than I do so I'm concentrating on Florida this year. I'm enjoying the reprinted edition of the *W.P.A. Guide to Florida*; it is different from the modern guides that push the tourist attractions. I had a delightful 2,000-mile-drive last summer, first to Beaufort, S.C., were Frank and I used to live. Then I drove to Charlotte for a family visit." . . . Claudia (Mrs. **Josh) Crosby** reports Josh is back home after being in a nursing home getting therapy and is doing wonderfully well. She says, "He has progressed from wheelchair to a walker to a cane. He can now walk around the block accompanied. I took him to the symphony concert last Saturday afternoon." . . . Maxine and **Carole Clarke** drove to Portsmouth last December and attended a family wedding anniversary. Alex and **Munroe Hawes** also celebrated an anniversary on December 2. Congratulations to both couples! Cac was completing 16 years with the Coast Star at a Christmas party on December 20—his second professional career.

Betty (Mrs. **Norman) Patton** reports continued good health, good job, and good friends. She spent eight days in May taking a guided tour around Texas. Then she took her usual summer vacation on Cape Cod. Mid-November she spent a "cultural" weekend in New York seeing the Van Gogh exhibit at the Metropolitan Museum of Art, and also attended the City Center Ballet and a good play. . . . Christmas greetings were also received from Ruth and **Irving Jakobson** and Dorothy (Mrs. **Joseph) Wenick**. . . . In a phone call from **Bob Miller** on January 29 I learned he was going to spend Christmas with one of his daughters in Virginia. He is planning to attend Alumni Day on June 6-7 and will fly to Hyannis to stay with **Whitney Wetherell** that weekend. He is taking a trip to Bermuda for a week's stay in May with one of his grandsons, Robert Miller III.

A news clipping from the *Boston Globe* tells of the death of **Preston Wood Smith** of N. Weymouth, Mass. on January 6, 1985. Preston Smith was a professor of physics at Clarkson College of Technology from 1943 to 1956, and professor of mathematics at St. Lawrence University until his retirement in 1966. He was a retired army captain and briefly attended Harvard before his appointment to West Point, where he graduated in 1918. Our sympathy goes out to his family.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 11203; **Josiah D.**

Crosby, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden,** Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

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Many of us remember that two of our classmates, **Bill Elmer** and **Eastman Smith,** were exceptionally able musicians, Bill on the piano and Eastman with the violin. Both have maintained and even added to their skills over the years. Bill has recently completed his opus 33 piano concerto piece "First Love," which he performs creditably with his "84-year-old fingers, chromatic runs and descending octave passages and all." A note from Eastman to Bill last Christmas reads in part: "Five weeks before my date to appear in our Musical Moments Society, it occurred to me that Lalo's Symphonie espagnole or my edition of the themes from the symphonie required greater power than my longtime temporary 'recital violin' could provide. Accordingly, all other activities were cancelled in favor of a violin resurrection of the wreck of a 'Thiers à Paris 1825,' which I had acquired a quarter century previously for $5.00. And so the long cracks were repaired and two of my inventions incorporated. A standing ovation—enough to encourage an engineer from M.I.T. A 'concert violin' at last." Our compliments to Bill and Eastman.

From the Sloan School of Management report (Winter 1984): "**C. Collins Bray** is 86 years old and retired. In 'cleaning out' before going into a retirement home, he came across an article he wrote, 'An Apology for Extreme Diligence,' for the March 1917 issue of *Technology Monthly*." According to *Technique* '23 Bray entered as a freshman in 1918, so this article must have been written while he was still in Framingham High School. . . . **Roy Stone** had some problems in 1984—cataract surgery in March from which he made a good recovery. In September, he fell and broke a hip joint, and had to have a steel ball implant. He returned home from the hospital in late October and got a walker, which enabled him to visit the doctor, attend three concerts, and the M.I.T. fall meeting in St. Petersburg. His children and grandchildren are all doing well. To Roy and Marian, we hope to see you again in 1987.

Phillip B. Holmes, retired for many years in Dunedin, Fla. is still busy with local volunteer work. In December 1983 he married Mildred Gray Turner. He has seven grandchildren and four great grandchildren living in Honolulu, California, and Texas. . . . **George Dandrow** writes, "Just hangin' by my thumbs from the low branches trying to keep out of the high winds." If you don't remember, George was a hammer thrower on the 1920 Olympic team.

Dwight Elliot Stagg, 86, of Bridgeport, Conn. died November 13, 1984. He was president of the Hawley Hardware Co. in Bridgeport. He was a member of Delta Tau Delta fraternity, which included a number of outstanding classmates. I think particulary of **Al Browning, Larry Davis,** and **Heinie Horn.** Stagg is survived by his wife, a son, a daughter, and seven grandchildren. . . . After a long illness, **W. Raymond Hewes,** 85, of Needham, Mass. died December 24, 1984 at his home. He had been a sales engineer for DuPont. He served with the army in World War I and during World War II headed the gasoline rationing board in Needham. He is survived by his wife, a son, a daughter, and seven grandchildren. We extend our regrets to the families of these classmates.—**Yardley Chittick,** Secretary, Box 390, Ossipee, NH 03864

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Mrs. **Herman Swett** writes that she moved on March 25 to 22 Capps Quarters, Hampton, Va. 23669, a waterfront property on historical land on the Virginia Peninsula. The architecture is inspired by the Williamsburg Town House. Proximity to Chesapeake Bay makes for many water activities. Her daughter and son-in-law, Dr. Joseph A. Stern, '49, live within a mile of the new place, and grandchildren also live nearby. . . . **Hugh Chase** says that he is still going, but lately is plagued by assorted ills. . . . **Arthur Belyea** died last December 16. He graduated with our class in chemical engineering and went on to take his S.M. in chemical engineering practice in 1924. He was with the Bethlehem Steel Co. for a year, then Consolidated Edison Co. of New York until his retirement in 1966. He was a director of the American Society of Testing Materials 1960-63, was active in the research committees of the American Gas Association, a member of the Society of Gas Lighting, and a charter member of the Society of Gas Operations. He belonged to the Old Saybrook Historical Society, and served a term as selectman in 1971.

William Winsor also died last December 16. He graduated with our class in chemical engineering, spent two years in various rubber manufacturing plants, then went with Union Carbide, Western Electric, and General Chemical Corp. successively. In 1927 he joined Reinhold Publishing Corp., publishers of technical and scientific magazines, in New York, as advertising salesman, later becoming district manager of their Cleveland Office, and eventually director of the firm in New York. He resigned in 1964 and became executive director of Second Class Mail Publications, Inc., an association of newspapers, magazines, and business publications. He was a member of the American Society of Metals, Metal Powder Industries Federation, Society of Plastics Industry, National Industrial Advertisers Association, and chairman of Washington Legislative Committee of Associated Business Publications, Inc. He was a member of the Chemists Club and the M.I.T. Club of New York. His hobby was contract bridge.—**Richard H. Frazier,** Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

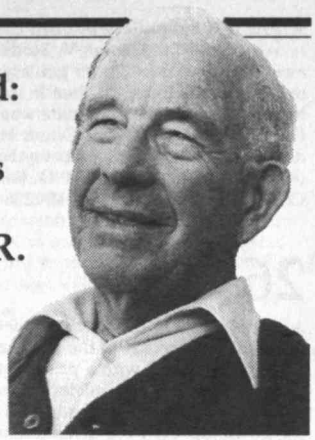
24

Roland Black notes: "October—chasing crickets in kitchen. Heart seizure—eight days in hospital. Weeks of do nothing! Now back in harness. Martha and I heading for Panama Canal cruise in January 1985." . . . **Douglas Montgomery** reports: "Only special news is that my wife Margaret, died September 21, 1984 of old age infirmities." . . . The daughter-in-law of **Howard E. Whitaker** advises us that "Whit" passed away October 11, 1984 in Chillicothe, Ohio. He earned an S.B. and S.M. in chemical engineering practice and then joined the Mead Corp. in Ohio, where he rose from pulp mill superintendent to vice-president of operations in 1949. We suspect that he retired as president and as director of Mead Corp. He was a member of the War Production Board in 1941-1943 and the Economic Cooperation Administration in 1948-1949. A member of Theta Xi, he was active in many clubs and associations as well as president of a Boy Scouts council.

While visiting Washington, D.C. during Thanksgiving, your secretary called at the home of **Luang Videt-Yontrakich** in Chevy Chase. He was shocked to learn that Videt had died September 21, 1984 following an auto accident. We knew him in Course I as "Soonchong Punyagupta." After receiving his S.B. and S.M. in civil engineering, he became head of the Thai Royal State Railways. In 1961, he was appointed Education Counselor in the Washington Royal Thai Embassy and was honored by the title of "Videt-Yontrakich." He and his family now carry the name. **Don Moore**'s daughter, Sandra Faber, professor of astronomy in California, recently named as one of the eight most accomplished young American astronomical scientists, was invited to a February White House luncheon. She was honored when seated beside Vice-President Bush. We have no information that "Star Wars" was discussed. . . . By the time you read these notes, **Herb Stewart** will have completed his second test of a European "Drive-A-Car" in the mountains. Starting from Zurich, Switzerland, he headed through Innsbruck, the Brenner Pass, Trieste, Italy, and back to Zurich via Dubrovnick (Yugoslavia) on the Dalmatian coast, thence to Vienna and Salzburg. His enthusiastic response was, "Gotte Dammerung!" More recently, he spent a few days in Florida visiting the **Eugene Quirins** in Vero Beach. He also contacted **John Fitch** by phone but was unable to round up a luncheon group.

Dick Shea, free-lance columnist for the *Sun City Center* (Florida) *Gazette* , sent two clippings. His style consists mostly of M.I.T. human nature exposes, generally dated and spiced with questionable humor. Also, Dick is trying to consolidate our Florida contingent.—Co-secretaries: **Russ Ambach,** 216 St. Paul St., Brookline, MA 02146; **Dick Shea,** 7 Barkley St., South Yarmouth, MA 02664

Needed: More Friends in the U.S.S.R.



"We've got to take action, to change course," says Ray C. Ellis, '22, of Sarasota, Fla. But to Ellis the route to better U.S.-Soviet relations lies not in the hands of the governments but the countries' young people. He's working for a college-level student exchange program—perhaps 500 Soviet students a year in U.S. colleges and universities and as many in the Soviet Union. Ellis says he found a sympathetic audience at the University of Kiev, in the Ukraine, where the provost promised to explore the possibilities.

25 60th Reunion

A letter from **Franklin Fricker** brings the happy news that on last October 29 he was married to Marion V. Mitchell. The wedding was held in Naples, Fla. with about 28 relatives and friends in attendance. Franklin and Marion hope to attend the 60th reunion, which is now but a few days away. Also, coming up in August is the Fricker family biennial reunion, which this year will be held in the Lake George area. Franklin still continues his community activities at the hospital, with Meals on Wheels and at his church. He has been much interested in Elder-hostel, and during the past two years has attended programs at Savannah University, Monteville University, and Cranbrook Institute. He has found it stimulating to hear and read material in the fields of art, music, history, computer science, etc.

Don Taber reports that travel is still his favorite hobby. Last June he visited Vienna, Salsburg, Oberammergau, Heidelberg and Amsterdam. . . . A short note from **Samuel Maddock** states, "As an ancient one, my recliner is active." . . . It is with

sorrow that the passing of three classmates must be recorded. Mrs. **George V. Stottman** passed away in New York City on January 5, 1984. Colonel **George Oetinger, Jr.** died in early 1984 in Monticello, Fla., the exact date was not provided. Dr. **Charles H. Bowles** of Center Harbor, N.H. died on June 26, 1984.—**F. Leroy Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650 (617) 945-2236

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A recent article in the *Hartford Courant* adds some interesting anecdotes to the many about our **Stark Draper**. Illustrated with a picture of Stark at the controls of a 707 jet simulator at his Cambridge Lab, it tells of his accepting in 1961 the design of the guidance system to take men to the moon and back and his desire to be the navigator of the first manned flight, a wish rejected by the Space Administration. Seven missions to the moon were completed with his system without a single failure. During World War II, Doc's major contribution was the development of navigational and gunsight devices which were of critical importance in our winning major naval battles in the Pacific. The Draper labs continue to develop the high technology required for U.S. military capabilities despite the harassing tactics of the local nuclear-freeze advocates, and Doc continues to go to his office daily even after a stroke last summer. A brief note from **Henry Jones**: "Still active on boards of Blue Cross, Family Service, and Community College of Philadelphia—past chairman of the board of the latter two. Travel a good bit. Hope to get to China and Hong Kong this May." . . . We received a card from **Juan Villanueva** after his return to the Philippines from his recent and only visit to the U.S. Since his address is not listed in the *Alumni Register*, we repeat it: Guinobatan, Albay, Republic of the Philippines. . . . **Louis Taylor** writes: "Ruth and I celebrated our 55th wedding anniversary in June. We are looking forward to the 60th class reunion in 1986."

Last August Fannie and **Crockett A. "Dave" Harrison** gathered for the 300th anniversary of ancester Bartholomew Stovall's arrival in the Virginia Colony in 1684. The three-day celebration attended by about 1,000 descendants, was filled with banquets, tours, genealogical sessions, exhibits of heirlooms and an all-day barbecue. Fanny and Crockett's family was represented by their five daughters, grandchildren, great grandson Yoshihior Ono and his mother Jennie Granger Ono, and several nephews and cousins, making a total of 27. Having achieved a second breath a few days later, the Harrisons were off for several weeks to the Maritime Provinces, returning via New York City with numerous stops to visit friends and relatives on the way and return.

The November issue of *The Audubon Magazine* features **Dick Pough** and his tremendous contribution to the preservation of thousands of acres of land for conservation purposes, including the $55 million expended through the Goodhill Foundation, which he has handled. Dick once gave my wife Evelyn, who was suffering with a fractured wrist, detailed instructions on how to walk properly through woods and fields carrying camera equipment, binoculars, and other impediments in a fashion such as to avoid such unnecessary accidents. As in the case with so many of us, his career was fostered by the support of Moira Flannery, a Smith graduate whom he married in his early New York days with the Audubon Society. Moira was able to augment Dick's slim earnings and support their two small boys by running a mail order gift business from the basement, selling real estate—anything to keep Dick in the bird world. In 1945, in an article in the *New Yorker*, he warned of the serious consequences that would ensue from the continued wide and careless use of DDT; coincidentally, he became acquainted with the young marine biologist Rachel Carson long before she become involved in her fight against indiscriminate use of chemicals. In 1948, Dick joined the American Museum of Natural History as chairman of its Department of Conservation and General Ecology. he has published several Audubon bird guides, as well as a field guide to rocks and minerals. The Poughs in recent years have acquired four acres of land and a house for their own private perserve on Martha's Vineyard. We hope they can make the 60th Reunion next year so that we can hear in person the many tales they have to tell.

Although the *Alumni Register* lists **Robert H. Clarke** as living, a delayed notice relates of his death on November 4, 1983. No further information is available.—**William Meehan,** Secretary, 191 Dorset Rd., Waban, MA 02168

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We are glad to receive a note from **William H. Richards** of Forestville, Cape Cod. On January 19, Bill and Helen enjoyed a 50th weddding anniversary get-together at their home, attended by 125 guests from all parts of the country. The party was a surprise arranged by their three daughters and son. Earlier, they had celebrated the occasion by taking a ten-day cruise on the new Royal Princess cruise ship with the entire family (including five grandchildren). Bill has been a leader during this past half-century in the mechanizing and irrigating revolution of farming. He has terminated the 400-acre prize vegetable farm where, among other accomplishments, he developed a special strain of broccoli seeds. . . . **Theodore Ordman**, of Stanfordville, N.Y., writes that he would like to contact **Howard A. Chinn**, but the Alumni Association does not have his address. Ted suffered a compound fracture of his left ankle last June and has been hospitalized twice since, with casts galore and ultimately a support plate insertion. "I am still unable to walk unaided but must hobble with a walker. Even going to the mailbox across the road is forbidden me. My dear wife Valda has nobly borne the burdens entailed."

A highlight for our class and all M.I.T. was the recent television documentary about the life of **Harold E. Edgerton**, shown on *NOVA*. What a marvelous life story of a modest country boy from Aurora, Neb., who comes east to M.I.T. and flourished in the electrical-electronic age that our class has spanned. No more satisfying biography could be produced than this video presentation. **Frank Massa** recently announced that Hal has been elected to be a director of Massa Products Corp. in Hingham. Frank is still active as a consultant and owns many active patents which provide protection for his sonar devices. Maybe together they will find more sunken treasures. . . . Another entrepreneur and inventor is **Harold Hein**, of Marblehead, who 25 years ago was vice-president of *METCOM*, manufacturer of high power tubes in Salem. He was the co-inventor of the strobe-beacon—those powerful lights, flashing in series, that guide airplanes to airport runways, even in dense fog.

Randolph J. Peterson died of cancer on November 4, 1984, in Rochester, N.Y. He spent most of his career with Raymond Concrete Pile Co. of Baltimore. After retirement in 1968, he and his wife, Jean, moved to Pittsford, N.Y. to be near their daughter, Carolyn, son, Randolph, Jr., and grandchildren. . . . **George D. Fexy** died last September in Kirkland, Wash. George was active to his last, as portrayed posthumously in the November/December, 1984, notes.—**Joseph C. Burley**, Secretary, Box 416, R.F.D. #3, Epping, NH 03042; **Lawrence B. Grew**, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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We have a very nice letter from **Al Gracia** who aspires to the status of octogenarian this year. We are sorry to learn that 1983 was a difficult year from him as he recovered from the loss of his wonderful wife, Josephine. He and Jo had been married nearly 54 years. However, he is now starting 1985 "happy, healthy, and on an upbeat."

Priscilla and **Roger Haven** report that winter was a bit late in arriving at Fryeburg, Maine, but snow it did. Roger has already reached his 80th and was prompt to say so. Welcome aboard, Roger! . . . Commenting on the 55th classbook, *'Thoughts and Sentiments,'* **Ben Draper** says it is interesting to see how others cope with retirement and age. . . . A short note from **Jack Rouleau** just sends his greetings. . . . **Harlan Paige** gives 8-16 hours of time each week to his hometown hospice. He finds it very rewarding.

A beautifully expressed letter from Allece (Mrs. **Thomas E.) Garrard** to Bill Hecht reminisces about our great 50th reunion, which she attended with Tom. Her concluding words: "May M.I.T. always celebrate 50th reunions for graduates to go back to and take along their spouses. I should like to thank you, as the wife of Tom Garrard, for an occasion which affirmed my husgand's respect and affection for his school and gave us delightful memories."

An upbeat note from Mary and **Max Parshall** assures us that they are in "fair health" thanks to good medical attention. We congratulate them on their 50th wedding anniversary, which was celebrated on November 11, 1984. We have photographs taken on that occasion which shows both of them looking well and very cheerful. . . . Somewhat because of her arthritis, Louise and **Ernie Knight** restricted their travels last year to the U.S. Northeast and Canada, with visits to family and friends. The wild partridge episode (see class notes, November/December 1984) was such an unusual event it was made the subject of their holiday greeting card.

A recent color photograph from Marie and **George Chatfield** shows them both still looking very young. Please tell us how! . . . Olive and **Newt Foster** returned to Florida to spend the winter months in their trailer at the campground in Flagler County. This could be their last winter in Florida since they are considering a retirement village in New Jersey. Last summer they took two of their grandsons on a trip to London, England. . . . Jan (Mrs. **John) Chamberlain** Sawyer is still a lively traveler. Last fall she made a trip to France and Spain, then off to Chile for Christmas with her daughter. She will be back in Massaachusetts for her early summer gardening. . . . Jo (Mrs. **Edward) Shiepe** says she is still reading and rereading the 55th reunion classbook, *Thoughts and Sentiments*, for inspiration and to dwell and to ponder, again and again.

Once again we congratulate our outstanding classmate, **Bill Hurst**! We have learned that Bill has been chosen by the National Academy of Sciences, Washington, D.C., as a distinguished scholar in an exchange program with the People's Republic of China. Bill will go to China in June 1985 for a one-month stay to lecture on petroleum reservoir engineering, his field of expertise.

A letter to Frannie and **Jim Donovan** from **Morey Klegerman** brought the sad news that his wife, Claudia, had died of cancer on October 19, 1984, after three months of illness. From all of us, our deepest sympathy is expressed to Morey and his family.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

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Everett P. Weatherly Jr., of Shawnee Mission, Kans., and his wife Marion are enjoying their retirement years with relatively good health, doing some traveling, playing bridge, and tennis. . . . **Rolf A. Zurwelle** of Walhalla, S.C. is thankful for continued good health which enables him to continue his design business. . . . **Professor Fred S. Eastman** of Walnut Creek, Calif., has moved to Rogue Valley Manor where he and his wife

Louise enjoy indoor as well as outdoor lawn bowling, and he continues his daily hiking most of the year. . . . **L. Malcolm Mosher** of Marshfield, Mass. has recently moved from his apartment of 26 years because it was sold. He also reports health problems which require medication for survival. He sends regards to all. . . . **William H. Lerner** of Elyria, Ohio, writes, "When my wife died five years ago, I considered retirement but decided against it. I am operating a small machine shop in Ohio and fly to New York City every month for a board of directors meeting of a fair-sized chemical company that employs about 250 persons."

Anthony J. Perry of Moneta, Va. writes, "Ruth and I are well and enjoying our retirement years. Sorry conflicting personal activities kept us from attending our 55th." . . . **Donald S. Hersey** of E. Hartford, Conn. retired from Pratt and Whitney, Division of United Technologies, in 1967 after 39 years of service. He keeps busy with Men's Club meetings, flower gardening, painting (art), bridge, piano playing, reading, and some traveling with his wife of many years. . . . Sally and **Bill Bowie** of Olmstedville, N.Y. are well and enjoying their home in all seasons. . . . The following members sent year-end holiday greetings: Marion and **Robert Pride** from N. Palm Beach, Fla.; Ellie and **Jerry Gardner** from Belmont, Mass.; Claire and **Arthur Bearse,** Gloucester, Mass. and Florida; and **Butler King Couper,** Tryon, N.C. He has just received his advance class, ham radio license, call letters KA4AOZ. **Dick Piez** of San Mateo, Calif.: "Thank you for your dedication and thoughtfulness on behalf of Class of 1929." . . . **Bill Baumrucker** writes, "I am the card writer this year. Doris fell last week, broke her hip, and cracked both wrists. The doctor says the bones went back together fine, so all will be well in time. Meanwhile, she is mad at herself. She says this sort of thing is supposed to happen to *old* ladies."

From Mary and **Frank Mead:** "I play golf four times a week, and Mary plays at least once. We play bridge a lot and many other social activities. We are enjoying the fruits of our past labors." Mary says, "After 40 years, I finally got Frank to help me write 200 cards. It wasn't easy." Mary will be celebrating her 60th reunion at Lesley College in Cambridge, and Frank is delighted to escort her to such a great event. They both enjoy good health. . . . **Larry Moses** writes, "I was disappointed to miss our 55th reunion. Kay's health has not been very good for the past eight or nine months. In August, our daugther Kathy gave birth to a fine son, John Loring Harris IV. We have four grandchildren now. Our son Larry is still working with Advanced Technology in Heidelberg, Germany. We expect a visit from them in a week. He is a retired colonel, U.S. Army, after 26 years of service. My health has continued to be excellent, although I have had that rare disease, amyloridosis, for nearly three years. Chemotherapy pills have kept it under control with periodic check-ups at Veterans Administration Medical Center in Durham, N.C., only about ten minutes from our daughter's home. Best wishes to all."

Thomas W. McCue of Newton Highlands, Mass. is still carrying out various business enterprises, though 1984 was a disappointing year. He does volunteer work at Children's Hospital, as well as telephone solicitations for the M.I.T. Alumni Fund, for which he received recognition last year. He sends his best wishes to all. . . . **George McKenna** of Vero Beach, Fla., has sent me a brief resume of his professional career. He received his master's in electrial engineering in 1930 and joined New England Telephone in Boston as transmission engineer. The depression bounced him into commercial operations in 1933. In 1941, he joined Chance Vought Corp., division of United Aircraft in Stratford, Conn., as personnel manager. From 1945 to 1955, he was associated with RCA as assistant director of personnel. Later he became vice-president of sales and services of Toledo Scale Co. In 1955, he moved to his present address in Vero Beach, doing consulting work, then back to personnel director for Vero Beach. For three years he was assistant to the Indian River County administrator, retiring in August 1976 at age 70. He and his wife attended the M.I.T. Florida Festival at Cypress Gardens a few years ago, as did Marion and **Robert Pride, Harold Pease,** Helen and **Neal Wells,** and your secretary and wife Helen. It was a memorable weekend for all those who attended.

I regret to announce the death of **William Lowery** of Plymouth, Mass., on November 21, 1984. He had been employed as an electrical engineer for Raytheon Manufacturing Co. for 34 years before his retirement. He was a Plymouth Town Meeting member for eight years, a member of the Church of the Pilgrimage, the Round Table Club of Plymouth, and the Republican Town Committee. He is survived by his wife, a son, a daughter, and five grandchildren.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

30 55th Reunion

Joe Harrington is recipient of the 20th annual A M award from *American Machinist* magazine, for "perceiving computer integration as the key to the factory of the future, helping further its implementation and contributing to the understanding of the essential nature of manufacturing." He is also subject of the cover story in the December, 1984, issue of *American Machinist*, wherein he is described as "a manufacturing visionary, a man of uncommon intellectual interests who is a great example that age has no bearing on vigor, creativity and the continuing pursuit of excellence." Joe's second book in this field, "Understanding the Manufacturing Process," was published last year. Alene and Joe live in Wenham, Mass., where Joe has been town moderator for many years. . . . By coincidence, we have another Wenham item at hand this month. **Reg Tarr** reports that he has been Wenham's assessor for over ten years and is now starting his fourth three-year term. Dorothy and Reg are definitely planning to attend the 55th Reunion, which is to be held only ten miles from their home. . . . **Mel Blackwood** reports from Franklin, N.H., that he has become a member of the M.I.T. Club of Central New Hampshire but hasn't been able to attend any of their meetings because he spends the winter months in Silver Springs, Fla. Mel says that last spring he met New Hampshire Governor Sununu, '61, at a convocation of Developmentally Disabled People at Sunapee Park.

Joe Devorss and his wife are still living in the Washington, D.C. suburb of Falls Church, Va. Joe reminds me that in the summer of 1929 he, **Jeff Wyman**, Randy Binner, '31, and I drove 11,000 miles through Europe in a Model "A" Ford named "Entropy." . . . **Ralph Swingle**, like so many of our classmates, is now a Floridian; he and his wife Dorothy live in Ft. Lauderdale. Ralph retired in 1971 as associate general patent counsel for Westinghouse Electric Corp. after 40 years of service. . . . **Morell (Hijo) Marean** is now "back to good health after a couple of short hospital stays." He has resumed tutoring fourth and sixth grade students in math three days a week. . . . **Sol Uman** and his wife spend summers in Hunter Mt., N.Y., and winters in Ft. Lauderdale, where Sol has attended several M.I.T. meetings. Sol is still involved to a small extent in engineering and construction work.

Over the Christmas holidays, Louise and I took a 12-day trip through California, during which I attempted to touch base with several classmates—with somewhat downbeat results. When I called **Howard Gardner** in Laguna Hills, Howie answered and it was soon evident that he was not his usual ebullient self. After a few minutes Teddy came on the line to explain that Howie had developed Alzheimer's Disease. In San Jose, I called **Norman Dolloff**'s home, only to learn from Phyllis that, as reported last month, Norm had died several months earlier. In Rancho Mirage we had better luck. We learned by telephone that **Jim Biggane** was alive and in good health, and we spent a pleasant hour with him and his wife in their home overlooking the fifth fairway of one of the numerous golf courses in the Palm Springs area. The Bigganes indicated that they would probably come to the 55th Reunion. . . . As this is written, **Joe Harrington** had received 27 firm commitments to attend the Reunion and 30 "hope to" and "plan to" responses. Since this is the last issue before the Reunion, let me remind you that the time is June 5, 6, and 7, and the place is the Colonial Hilton in Lynnfield, Mass.—**Gordon K. Lister**, 294-B Heritage Village, Southbury, CT 06488

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Alexander H. Kuhuel writes, "Retired, age 76. Active as a volunteer math tutor, grades 5-12." . . . **Walker H. Holler** says he is now living in a very nice retirement home in Chapel Hill. . . . **A. Harry Wagner** writes, "Retired as president of Southern Brick Contractors, Inc. of Richmond, Va. Currently executive secretary, Virginia Concrete Masonry Association, State Association of Block Manufacturers." . . . A Christmas note from **Bill Stellrecht** reads, "Christmas is always a good time to remember old friends and report about the work and pleasure experienced in the past year. Well, I am still working as a patent attorney, although at reduced hours. Three younger partners, including my son-in-law, are carrying on the main part of our business. We have a great many connections with the U.S.A. My infringement lawsuit is still pending before the appeals court in Washington. My wife and I enjoy traveling a great deal. Last year we visited South Africa and in the summer went on a cruise in the Baltic sea, going as far as Leningrad, Russia. We will spend Christmas and the New Year at the Canary Island and Maderia. We try to remain fit for new pleasures in 1985, and one of our evenings is ballroom dancing at a health resort in our neighborhood."

A sad note from **Fred Elser** says, "Unfortunately, we didn't get to the 'rest' home in Kansas; we missed it by 12 days due to a call for us to come back here, as our oldest, Janet, has terminal cancer. She is at a rest home here in Honolulu about 30 minutes away and we are in an apartment. Janet seems to be holding her own. Between my Parkinson's and Marty's arthritis, things get a bit difficult. Our younger daughter, Margy Arthur, Pleasanton, Calif. was here for two weeks and got Janets things out of her apartment. She is back in California now, and we do miss all the things she accomplished! I am not on the air now—don't seem to have much interest." . . . More sad news—**Larry Bernard**'s wife, Janet, passed away on December 28, 1984. The latest address I have for Larry is: Kendal-at-Longwood, Kennett Square, PA 19348. Our sincere condolences to Larry.

Hope and **Randy Binner** write, "Christmas will be a very special day for us. Curling has started so Randy is happy. I curl very little." . . . Jean and **Claude Machin** write, "We had fantastic China trip last September and October." . . . **Gabriel S. Cristofalo** writes, "Slowed down since my kidneys stopped functioning in January, 1984. We plan on a couple of cruises during which I can have dialysis treatment. I surely hope that Renati can make arrangements to attend the 1986 Reunion." . . . **Dave Schweizer** writes, "I am still active in the lumber business, have a farm for a hobby, and generally remain active in all of our other interests. My wife and I have celebrated our 50th wedding anniversary. Perhaps I will make our 55th Reunion."

The Alumni Association has notified us of the following deaths: Professor **Ernest H. Lyons, Jr.**, of Laguna Hills, Calif., died in 1984. . . . **John V. Berger**, of Denver, Colo., died on October 9, 1984. . . . According to a newspaper clipping, **Glen Goodhand** died of cancer on September 11, 1984. He was a retired brigadier general who

logged more than 500 combat flying hours as an artillery liason pilot during World War II. He was inducted into the Army Aviation Hall of Fame in 1975. After retirement into the Army he was the Washington representative for Boeing Vertol Co., and he retired a second time in 1979.

A note from your assistant secretary reads, "Louise and I crossed Florida twice in the last month visiting daughter Barbara in Roswell, Ga. and son Jack on their boat in the Exumaas (flew from Ft. Lauderdale). Then visited a friend on Longboat Key, but we didn't get close enough to Mt. Dora either time to look you up. We went both sides of Lake Okechobee and saw some parts of Florida we hadn't seen before. Coming home we stopped overnight with Loretta and **Enio Persion** in Silver Spring and had a very nice visit. Enio has been in and out of the hospital, his heart acting up. Enio reports personally: "I am doing much better now but must take it easy for a while until they decide what to do about a leaking heart valve. Through all this, Loretta has been fine but works hard cooking and taking care of me. In September, the doctor decided I have diabetes, so I must watch my diet but have been able to control it. We had been unable to travel and miss it very much. We hope to be in fine health for the 55th and look forward to it." A news clipping tells of the death of **Roger M. Kelly,** 78, retired naval architect. He graduated "magna cum laude" from M.I.T. and followed it with graduate work at Northeastern University, Harvard University, and M.I.T.—**Edwin S. Worden,** Secretary, P.O. Box 1241, Mt. Dora FL 32757; **John R. Swanton,** Assistant Secretary, 27 George Ave., Newton, MA 02158; **Ben W. Steverman,** Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02380

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Thank you for responding to our class' Christmas greetings. We have 35 replies, enough material for several issues. . . . **G. Robert Klein** is still very active in over 20 civic, religious, cultural, or trade organizations around Cleveland, Ohio. Recently, through generous grants by the Kleins, it was possible to commission Charles Wuorinen to compose "Moves and Shakers," which was performed by the Cleveland Orchestra. . . . **Francis T. Gowen** has just returned from his annual trip to Italy. You can find him at Cape Cod where he is busy refurbishing old houses—carpentry, painting, and gardening.

We have received the sad news that **George E. Colby** died in Florida on October 3, 1984. George was founder of Magnetic Seal Corp., Barrington, Mass., as well as president of the International Braid Co., Providence. He was active in many civic, professional, and social organizations. Besides his wife, he leaves a son, two daughters, eight grandchildren, and two great-grandchildren.

It is also my sad duty to report the death of **Earl F. Anderton** in Zurich, Switzerland. He and his wife Sally celebrated their 50th wedding anniversary in September 1983. Earl worked for 44 years with the Scott Paper Co. In 1976 he retired and went to work for Ekono, Inc. as a consulting engineer. Earl had many hobbies, traveled widely, and was active in many organizations. He is survived by his wife, daughter, and three grandchildren.

We learn that **George W. Palmer,** 83, a retired army colonel, died on December 22, 1984—one month after his wife died. George graduated from West Point and then came to M.I.T., where he received a degree in mechanical engineering. His long and varied career took him to many American cities and many foreign lands where he held many responsible positions. He is survived by three children and four grandchildren. . . . **John Walker**'s daughter, Patricia Courtin, answered the Christmas greeting with a letter saying her father died in 1972. She recalls the warm feeling that he had for M.I.T. and remembers well the tours he gave her and her sister around Cambridge. He would be pleased, she is sure, to know that his grandson will graduate from Texas A&M University in the spring—civil engineering, of course. . . . **John Northup** writes that **John F. Crowther** died of a heart attack on October 19, 1984. John recalls they attended the 50th reunion together.

We go to print too soon for me to give a report on our class mini-reunion in Sarasota, Fla. That will be in the next issue.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA

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Our class president, **Dick Morse,** has had a second cataract operation, and reports that the two operations have improved his tennis so much that he recommends the procedure to all of us who need it. . . . After our notice about coeds in the February/March issue, we had a letter from **Berj Tashjian,** who architects in Northbrook, Ill., and from **Leon Hyzen** of San Clemente, Calif., telling us that here are four lady members of 1933—**Gertrude Elvira Ebbeson, Margaret Burnham Kelly, Hazel Weld,** and **Frances E. Varney** (now Marshall), who lives in Weston, Mass. Berj notes that he practices architecture in the Detroit area, and has and would like to hear from some of you Rogers Building graduates. Three children are all engaged in the arts in one way or another—music, photography, audio visuals.

When we had our 25th reunion, **Leon Hyzen** was reported as a sculptor, photographer, and philatelist. He is still a stamp collector, serving as chairman of the finance committee for the U.S. Philatelic Classics Society from his home in San Clemente. . . . **Clarence Westaway** writes that he is better this spring after a spell of sickness last fall. . . . Anne and **Fred Murphy** went to Banff Springs on the West Coast last fall with Jane and **George Stoll,** our perennial treasurer, you know. Fred says he didn't see **Dave Nason** or **Frankie Gilmore** at Cape Cod in 1984, but plans to do better in 1985. . . . Eleanor and **Al Mayer** have been to England—they are one of our most persistant traveling couples. . . . **Leonard Julian** writes that the grandchildren are great, especially when they are all well. We will all agree with him. . . . I haven't had a reply from **Robert C. Ellwood** about where he went to get those 3,000 miles on his 1929 Lincoln last year, but when he answers, I'll advise you. . . . **Dayton Clewell** hasn't written about his trip to China. We hope those Chinese didn't keep him . . . we'll see.

Who of you '33ers are still working and what are you doing for money or to pass the time? I like being retired, and someday I'll have all the snapshots pasted up! Daphne says she doubts it, but I'm hopeful. Who ever thought '33ers would have grandchildren entering Tech? We're there, aren't we? If you are in that illustrious group tell me. . . . All goes well in the Carolinas. We had a low of just under zero last winter, and we didn't like it. How did it go in your section? I understand that it is not polite to write for letters, but your secretary is shameless . . . come on! Tell me something about yourself or some member of the Class of 1933 to pass along.—**Beaumert Whitton,** Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC 28210

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We have three more losses to report this time; chronologically, the first is **Herbert L. Gamer,** of Milton, who died in November after a long illness. Mr. Gamer was listed in Course VI-A but did not graduate. He served in the Army Signal Corps in World War II and, after the war, established the Tee Vee Supply Co. in 1947, which he operated until retiring in 1978. At that point he went back to school at Northeastern University, graduated with high honors in English literature in 1983, and at the time of his death was continuing graduate studies. . . . **Robert M. Elliott** died on December 14 in Norwich, Conn. He received his B.S. in physics in 1934 and stayed at the Institute for a Ph.D. in 1937. Most of his career was with King-Seeley Thermos in Norwich, where he was director of development when he retired in 1974. Dr. Elliott was active in the Rotary Club and the U.S. Power Squadron and was an incorporator of the William W. Backus Hospital. He is survived by his wife, two daughters, and a brother and sister. . . . **Karl A. Gardner** died on January 3 in Northridge, Calif. Mr. Gardner was part of a real M.I.T. family: his father graduated in the class of 1911, and his son in the class of 1968. Mr. Gardner's career concentrated in the area of heat transfer in the petroleum, chemical, and atomic industries. Over the years he worked for Cities Service Refining Co., Griscom-Russell Co., Yuba Consolidated Industries, M.W. Kellogg Co., and Atomics International. He received the 1972 Max Jakob Award for his work in heat transfer equipment. It is obvious from his memberships and awards that he occupied an eminent position in his field. To the families of these men I extend sympathy on behalf of all the class.

To turn to the brighter side, we have several Alumni Fund notes. The new form provides less space than before, but don't hold back—tack on an extra page. On one of these little forms, **Bob Ebenbach** writes, "Semi-retired. Recovering from June, 1984, triple coronary by-pass." Since it is almost four years since I successfully joined that club, I'm sure Bob is finding that he has received a new lease on life. . . . **Theodore Steinberg** writes, "I was the guest of honor at the 1984 meeting of the American Academy of Ophthalmology." . . . **John Newbegin** says, "We are thinking of putting our house in Easton on the market in the spring. We hope to acquire a place in the sun belt, but will stay with our summer home on Lake Champlain."

Irv Kusinitz writes, "Since my retirement in 1981, I spent a month in South Africa in the spring of 1983 and five weeks in China, Hong Kong, and Japan in the late spring of 1984. Ski trips to Switzerland and Colorado are of course, more routine; as are consulting visits to England, Mexico, and Venezuela. I am feeling very well in spite of the expected aches and pains (little ones). I am sorry to have missed the 50th Reunion, but was winding up the Far East trip mentioned above. I do hope to attend the mini-reunion in September and optimistically, the 55th." . . . Speaking of travel, your class secretary continues his peripatetic ways. My January week in Barbados was great—my sister and I went to Harrison's Cave and the Flower Forest, both places that anyone visiting the island should see. I'll be in Florida for most of March: one week with a nature group at the Everglades and two weeks visiting around the southern part of the state. I've signed up for the Belgium-Holland-France trip that was advertised by the Quarter-Century Club for late April through early May, and I've pretty well roughed out a late spring trip that will include Yugoslavia, Romania, and then Budapest and Vienna. I'll need the summer here on the Cape for me and my bank account to recuperate.—**Robert M. Franklin,** Secretary, P.O. Box 1147, 620 Satucket Rd., Brewster, MA 02631; **George G. Bull,** Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35 50th Reunion

Edward Woll writes from his Florida home that he received a plaque from General Electric, now on display in GE's Aircraft Engine Business Propulsion Hall of Fame. The plaque credits him as the "father" of the AEBG small military engine line—T58, J85, TF34, T700, F404—and of their commercial derivatives. Further, "His foresight, strategy and strongly executed initiatives provided the foundation for the eventual success of the F101 and derivative F101 and F110 programs over strongly entrenched competition." He was also honored by the air force for sponsoring the

zero defects concept in industry, and has received many other awards, including election to the National Academy of Engineering. Ed hopes to be at our 50th; we look forward to seeing him.

Wilfred H. Grosser will be rowing with the crew. He was on the Freshmen Crew in the spring of 1932, and we look forward to seeing him. By the time you read this, we may have enough oarsmen to man two shells! We may well be short of coxswains, however. If you can handle that job, please show up at the boathouse Thursday, June 6 by 9:30 a.m.

According to the latest figures, there will be 80 classmates at our 50th at the M.I.T. festivities and 13 less than that for the Wianno Club portion, plus 67 spouses and guests. Welcome to the Red Jacket Club, those of you who will be there. Details of how we did in the October *Technology Review*.—**Allan Q. Mowatt,** 64 Boardman St., Newburyport, MA 01950

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By the time you read these notes the 50th reunion committee will have met and the first mailing will be in the process of preparation. I urge your prompt response. Please read it carefully. I can not tell you what decisions the committee will have made because I can present alternatives, but the group must make the choices. I very much appreciate the many suggestions and responses I have received and hope that they continue to come in.

There is no other news this time. Perhaps some of you are planning to attend Technology Day and will have items for this column. I hope so!—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartford, CT 06091

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Robert Glancy of Old Saybrook, Conn. writes: "Enjoying retirement. Had a surprise Thanksgiving visit from our daughter (lieutenant colonel in the airforce) from Clark Field, Manila." . . . **Milton Lief** of Olivette, Mo. writes: "First grandson born into family, Derek Alexander Lief, son of Dr. Lawrence and Patti Lief of San Francisco, on November 30, 1984. All doing fine." . . . **Art Zimmerman** retired January 31, 1982 as vice-president of SIFCO Industries, Inc., and is now semi-retired working as a consultant. He is executive director of the Cleveland Commission on Higher Education. Art is also chairman of the ministry and fellowship board of Plymouth Church of Shaker Heights; Member, board of trustees of Hough House, (an inner-city center); and vice-president of the local chapter of the Sons of the American Revolution. He plays tennis several times a week and traveled to England and The Netherlands in May. He and his wife celebrated their 40th anniversary in September. They go to Wisconsin frequently to see their daughter Jane and family (Anne and Lindsey, granddaugthers). Wife Agnes's interests are: church work, garden club, and Western Reserve Historical Society. Art writes, "I'm enjoying my level of activity very much. Enough to keep busy without feeling burdened. Have taken business trips this past year to Florida and Denver. Saw **Ed Hobson** a few months ago. (He spent the weekend with us). He and I are planning a joint reunion of our Harvard Business School advanced management program classes in June. See you in '87."

George Rosen went to work for Hamilton Standard in 1937 as the company's first propeller aerodynamicist and retired in 1977 as the company's chief of propeller research and development. When the Connecticut Aeronautical Historical Society was formed 25 years ago, they asked him to give a lecture on the history of the propeller. He was reluctant at first, but then acquiesced, and so began his career as unofficial company historian. Over the years, he collected documents and copies of photographs from around the world that stood him in good stead when producing *Thrusting Forward*, his new book on propeller history. The book is a 96-page full-color hardback. During the nine months it took to write and prepare the book for publication, Rosen put aside his retirement liesure activities, including sculpting, and moved back into an office at Hamilton Standard on a daily work schedule. The book was produced in time to be handed out at the Farnborough, England, Air Show in September. Now Rosen is pondering an even larger task. Having written *Thrusting Forward* as an informal history of the propeller, he is being pressed by co-workers to write a definitive history. "If I do it," he says, "I've got to put everything else aside." While he admits he will probably undertake the project, he has one task to finish first in West Hartford—a seven-foot impressionistic wood sculpture of a female figure, titled "Thrusting Forward."—**Lester M. Klashman,** Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

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Eureka! The secret to being a good class secretary is to get 1938 wives to send 1938 news to yours truly. Who's idea? Why, Ellen Coile's—wife for 33 years to **Russ Coile**. Ellen writes: "We moved to Pacific Grove, Calif. just over two years ago, having belonged to the group that thought someone had picked up the eastern seaboard and shaken it; result, all the fruits and nuts ended up in California. After 40 years of gainful employment, Russell was retired, and so we came here for his new job as deputy executive director of the Scientific Support Services Co. (a joint venture of Planning Research Corp. and Kentron International) which supports the U.S. Army's Combat Developments Experimental Center." Russ and Ellen are very active in local alumni activities. To 1938 spouses: respond to Ellen's challenge!

A letter from **Ed Hadley**, who, in case you have forgotten, is reunion gift chairman: "I've given so much to the Class of 1938 Scholarship Fund that Jean and I barely had enough money to go to Kenya, Tanzania, and Spain in January, but we made it." This is the old *Voo-Doo* editor's not-too-subtle way of reminding us all that we want a record class gift in 1988. Hint, hint.

Class President **Don Severance** has announced that **Dave Wadleigh** will be running that 50th reunion in 1988, and is already working on plans. If you have any suggestions, Dave or Don would be delighted to hear from you.

An addendum on **Dave Wadleigh**: at the January 28 Alumni Advisory Council meeting in Cambridge, he was presented the Lobdell Award for "his tireless, energetic support of the M.I.T. Club of Cape Cod, the M.I.T. Class of 1938, and the Alumni Association of M.I.T."

Arthur B. Savel passed away in January after a long illness. Arthur originally came from Winthrop, and had been a long-time resident of Brookline.—**Armand L. Bruneau, Jr.,** Secretary, 663 Riverview Dr., Chatham, MA 02633

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Jan and **Eli Dannenberg** moved from Cape Cod to Longboat Key, Fla., where Eli continues consulting. Eli earned his Doctorate of Science and Surface Chemistry from the University of Louis Pasteur in Strasburg, France. During his career, he wrote 70 articles and received 13 patents in the carbon black and rubber filler fields. Last October, Eli received the Award for Technical Excellence of the American Chemical Society. . . . Lucile and **Bill Brewster** made a month-long trip around the world. Their activities included diving on the Great Barrier Reef, where they weren't nibbled by the sharks and barracudas sharing the water. Homeward bound, they drove around the beautiful island of Sri Lanka, caught rainbow trout in the Highlands on Christmas, and spent New Year's Eve in the middle of a jungle reserve bungalow frequented by deer and an occasional leopard. Back home, the Brewsters' retired life includes membership on several boards; nonprofit good works, including the Nature Conservancy; a Presidential appointment as member of the National Advisory Committee on Oceans and Atmosphere; plus hunting, fishing, gardening, photography, and diving. . . . Billie and **George Cremer**, like the Brewsters, are retired. Their many activities include family, church, consulting, and a current two-month tour of New Zealand and Australia.

Mary and **Jim Barton** just returned to Seattle, after a three-week trip to the Caribbean that included St. Thomas and a stopover at **Gordon Pope**'s beautiful home in San Juan, Puerto Rico. Jim says that Gordon, also in his retirement, started raising Atlantic salmon and landlocked salmon in three fish-farm enterprises in New Hampshire and one in Massachusetts. Gordon and the Brewsters plan a mini-reunion in Puerto Rico during February. . . . **Earl Reynolds** reports that his son, Jack, played in the N.F.L. for 15 years, in 12 post-season playoffs (a No. 1) and in three superbowls. Earl, when Jack plays again in Seattle, why not fly over from Cincinnati, bring along some special tickets to the game, and **Jim Barton, Hans Bebie, Jack Alexander, Holden Withington** and I will join you for a mini-reunion tailgate party. . . . **Collin Alexander** continues consulting in high-vacuum evaporation and sputtering of thin films. . . . **Sears Williams** retired from Sverdrup and Parcel, and now consults from Olivette, Mo. . . . **Bob Pratt** has completed two years as president of the M.I.T. Club of Cape Cod. . . . **Irv Peskoe** is in his second term as mayor of Homestead, Fla., and is active in Educational Council work for the Institute.—**Hal Seykota**, Secretary, 1415 Seacliff Dr., N.W., Gig Harbor, WA 98335

40 45th Reunion

When you read this it will probably be less than four weeks to our 45th—Thursday, June 5, to Sunday, June 9. If you haven't made plans yet, rush to the nearest phone or wire **Jim Baird,** reunion chairman, Artisan Industries, Inc., 73 Pond St., Waltham, MA 02254, (617) 893-6800. We have had an excellent response for our first mailing. In addition to a fine program at both Cambridge and Woodstock Inn, Vt., we would also like to have a seminar. Members of our class will present their special interests. PLEASE let Jim Baird know if you plan to participate. **Ed Bernard,** our treasurer, submitted some statistics on dues payments by our members. Approximately 50 percent (250 members) are either fully (37 percent) or partially (13 percent) paid up.

For the past two years **Clement F. Burnap** has been in charge of business development for two consulting engineering companies (a general civil and a structural firm), designing tanker and coal terminals and offshore platforms for Russell Associates (Doug Russell, '44, president). Seeking a design-built capability, Clement secured a position as corporate manager of Marketing Service for the Dillingham Corp., which has divisions performing heavy construction nationally and internationally. Work with Dillingham was so demanding that he had to cancel his arrangements with the general civil, but continued his activities with Doug Russell, since what he designs is what Dillingham likes to build. He and his wife, Elaine, plan to attend the 45th. . . . **Raymond E. Keyes,** also plans to attend our reunion. During his first year of retirement (1984) he and his wife repaired their home roof, and a surgeon repaired Ray's shoulder for an old muscle tear. . . . **Jack Danforth** wrote to **Nick Williamson** about the reunion and received a sad note from his wife, Louise. Nick went through M.I.T. in a wheelchair and had been confined ever since. He had lots of courage. He died January 31 after a brief illness at his home in Pocasset, Mass. Louise indicated that he was looking forward to June and always spoke

warmly of his association with the Class of '40 and M.I.T. . . . Another sad note from a news clip. **Michael Morelli,** an electronic engineer with the government, died at his home in Alexandria, Va. on November 16. Michael was born in Italy and lived there before moving to the United States in 1928. A World War II Army veteran, he worked for the military as a civilian electronic engineer for 33 years. He is surived by his wife, Jeanette, three daughters, and one son.

From the first reunion mailing, the following notes were supplied by classmates who cannot attend. **Don Cole** writes from his home in LaHabra Heights, Calif., that he is sorry he can't come; he's promised to attend a grandson's wedding—plans to make the 50th. Don has not retired yet and has no plans to do so. Working at Rockwell on the Space Shuttle has kept him too interested to quit. . . . **Hal Davis** writes from Oakbrook Terrace, Ill. that he probably will not attend due to a conflict with his wife's reunion. He tried to make his 50th Harvard reunion in 1983 but instead ended up having an operation for cancer of the bladder. . . . **Phelps Walker** writes that he and his wife Maxine, are committed to an important governing board meeting of the U.S. Power Squadrons in Boca Raton that weekend, so they will have to wait for the 50th; however, he sends greetings and hopes that everyone has a great reunion! . . . Hope to see you all in June.—**Donald R. Erb,** Secretary, 10 Sherbrooke Dr., Dover, MA 02030; (617) 785-0540

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Robert Winalski writes from Richmond, Va. in reference to memories of **Harold E. Dato,** who died last year: "In 1937 and 1938 dormitory rooms were hard to get, so a few 'outsiders' gathered to rent a four-story brownstone, first on Clarendon St., and in 1938 on Exeter St. We had an elderly couple cook and clean for us. Our total cost amounted to $10 per week and later $11 a week, including food! It is hard to believe, but **Herman Lang,** '40, can confirm it. In this sparce, but actually comfortable setting, Harold was the prime arranger for détente with faculty members. I say détente, but Harold was a superb moderator to great discussions we had.

"Are there others who remember the T-Club, and who can elaborate about the bull sessions and sweet banquets of the mind. I will forever be greatful to Harold Dato, to his contributions to Tech life, and to my fond memories." Thank you, Bob for, a great letter. . . . **Leona Zarsky** called to comment that Harold Dato was editor of *Benchmark* and *Dorm Roomer* and during 1940 and 1941 general manager of *The Tech*.

We want to hear from Dr. **Austin W. Fisher, Jr.,** who has fully retired and is moving aboard a 31-foot ketch for some Caribbean cruising. He is making his base in St. Croix. . . . **W.E. Lifson** has retired from Exxon Research and Engineering, after 38 years of service. . . . **James F. Healy** has retired as chairman and CEO of Milton Roy Co. of St. Petersburg, Fla. He will continue as a consultant to the company. . . . **Norman F. Vandervoort** has retired as president of Belding Corticelli Thread Co. and writes: "Betty and I are in excellent health and are actively supervising construction of our retirement house in a beautiful setting in Kent, Conn. I will keep moderately active as a business management consultant after we settle in Kent next summer."—**Joseph E. Dietzgen,** Secretary, Box 790, Cotuit, MA 02635

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We're saved from being skunked for news this month by a long letter from **Bill Tallman**. He retired as CEO of the Public Service Co. of New Hampshire (PSNH) last March and is now a "professional journeyman carpenter, mechanic, and painter." He writes, "considering the unfolding, incredible, and frustrating saga of Seabrook, retirement has been very, very easy to take!" Bill continues to serve on the board of directors of PSNH and with Jean continues enthusiasm for sailing and travel. In October, Bill piloted a barge on the Canal du Midi, traveling with two other couples from Toulouse to Marseille.

One obit, **Nelson Evoy**, a quiet classmate who belonged to Sigma Alpha Epsilon but lived in the dorms. He graduated in Course XV, and we remember him as one of the founders of VU, the photographic magazine started during our junior year. Our sincere condolences to Nelse's wife and to the family.—**L.K. Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

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The strong but kindly visage of **Hugh Parker** stares out from the photo accompanying the announcement of his appointment last December as chairman and CEO of Business International Corp. BI is an independent consulting firm serving multinational organizations, with headquarters in New York City. Hugh, a former director of McKinsey and Co. and managing director of McKinsey's U.K. operations 1959-1974, succeeds former Secretary of Agriculture Orville L. Freeman as head of BI. Following his M.I.T. work in Course XIII, Hugh earned a B.A. in economics and engineering at Cambridge University in England. His World War II service was with an American unit attached to the British 14th Army in India and Burma. Thirty-two years with McKinsey gave him a wide range of experience with industrial organization and management, as well as directorships in two British corporations. Hugh belongs to a number of business and civic organizations in Britain, and is a member of the M.I.T. Corporation Development Committee. He is past president of the American Chamber of Commerce (UK) and of the M.I.T. Alumni Club of Great Britain. If anyone wants to call Hugh and congratulate him, I have his telephone number.

From Lancaster, Pa., **Bob Handler** reports that he and Marie are still enjoying retirement surrounded by five grandchildren. For the third year, Bob is president of the Meadia Heights Golf Club. Did anyone ever take up his offer and play there?

Ray Frankel confesses he was deeply moved by my piteous plea for news. A tear-stained letter reports on his activities. Ray has combined interests in technology and money in a firm called Technological Investors Management Corp., located in New York City. TIM manages client's portfolio investments in the growth areas of technology. According to Ray, this field has been quite rewarding, but in the past year has had its problems. He is also involved in several operating companies: as a director and co-founder with **Stan Roboff** of Cerametals, Inc., an importer of rare metals and rare earths; as a director of Sun Chemical, and also of Standard Microsystems Corp. Standard's president, Paul Richman's, '63, startup a few years ago was financed in part by TIM. Ray has maintained contact with **Hal Gershenow**, who was directing a textile research program in Tel Aviv, but returned to the U.S. a short time ago. Ray's travels have recently taken him to the Middle East, where he was impressed by the region's archeology, both underground and preserved in the modern-day medieval culture. He says he is now ready to stay put for a while in Larchmont with his wife Kim. She is a professional sculptor who has decorated their home with her work. Regretting that he missed the 40th reunion, Ray sends greetings to his classmates. . . . Thanks, Ray. Now, how about the rest of you out there?—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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The following have expressed an interest in the Williamsburg mini-reunion November 1-4, 1985. If your names do not appear on the list, or if you have not received any further information, please contact **Norm Sebell**, as some cards were returned unsigned. **Aquila, Ayers, Benedict, Biedenharn, Barmby, Barnaby, Boschen, Boucheron, Bowes, Breck, Brenner, Breymann, Brindis, Bromfield, Burdakin, Butter, Callner, Carpenter, Cayce, Chapin, Corona, Corry, Cross, Cummings, Cunningham, Demarkles, Docal, Dodds, Dowd, Eaton, Emberton, Farmer, Feroli, Field, Frodey, Gardner, Gastrich, German, Granlund, Hammarstrom, Harris, Hess, Hinchcliff, Heilman, Horrigan, Hull, Hunter, Jack, Jevon, Kase, King, Kispert, Kobick, Kratz, Kravitz, Lamadrid, Lamport, Lang, Lednicky, Lindemann, Margolskee, Meny, Miller, Morrison, Moyer, Peterson, Picardi, Rabinowitz, Rehler, Ritterhoff, Roos, Ruoff, Rush, Sadler, Sanders, Sebell, Shrier, Simpson, Smock, Stanley, Thiede, Toland, Turner, H., West, Whiffen, Woodworth, Wunsch, Wyrachowski, Ziegler.**

Arturo Morales was inducted into the Mexican Academy of Engineering on November 8, 1984. He would like to know who is going to the Grand Panama Canal Celebration, M.I.T. Quarter Century Club. . . . **James Weaver** was elected fellow of the American Institute of Chemical Engineers. Congratulations to both. . . . **Edward B. Walker** retired as president and CEO from Gulf Oil Corp. on November 30, 1984. At present, he is a director of Texas Eastern Corp. . . . **Burt Bromfield** reports meeting **Arnold Mackintosh** en route from Zurich to Cairo last October. They had not seen each other since ROTC days. They spent ten days cruising south on the Nile and then flying to Abu Simbel. Mac has retired from Kodak, and he and Barbara have been skiing, hiking, and traveling. . . . Burt also received a letter from **Mario Banus**. Mario retired last fall, and he and Barb have been busy building (with help from contractors) a new house in Beaufort, S.C. The saltbox faces the water, and large windows look over the river and marsh to the south. (Contact **Pierre Boucheron** and compare notes on wood stoves!)

It is with regret that we report the death of **Leonard T. Loforese** as a result of a heart attack in December 1984. He was as senior project engineer for Electrolux Corp. He was a lifelong resident of Greenwich, Conn. Leonard is survived by his wife Mary and son John. Our condolences are sent to her and family.—Co-secretaries: **Andy Corry,** Box 310, Hyannisport, MA 02672; **Louis Demarkles,** 53 Maugus Hill Rd., Wellesley, MA 02181

45 40th Reunion

As our 40th Reunion approaches, this Class and the Institute owe **Chris Boland**, 40th Reunion Gift Chairman, a round of applause and great thanks for a job well done. Chris is the individual that made it happen. Chris, we all thank you. Fran and I enjoyed seeing Chris and Jean recently in New Castle, when Chris was between careers—after a lifetime at Kidder Peabody, Chris retired at 60 in late January to join a venture capital firm in midtown Manhattan.

J.J. Strnad sends this excerpt from an article by Nardi Reeder Campion entitled, "Wellesley, '38: A Different World But In Many Ways the Best of Times." It seems most appropriate as we celebrate our 40th Reunion within days: "College reunions can be a competitive sport. At early reunions classmates compete with each other about jobs and incomes; at the 25th, it's spouses and children. After that they brag about their grandchildren and vacation homes while regarding, with envy and glee, classmates' waistlines, hairlines, and wrinklelines. With a 45th reunion comes a new phase of competition—the one described by Woody Allen when he said, 'Ninety percent of life is just showing up.' It is said that there are Three Ages of Woman: youth, middle age and 'you haven't changed.' But change is the name of the game. Consider: graduates of the class of 1938 were before the pill and the popula-

tion explosion which, inexplicable, went hand in hand—so to speak. We were before television. Before penicillin, polio shots, antibiotics and Frisbees. Before frozen food, nylon, dacron, xerox, Kinsey. We were before radar, fluorescent lights, credit cards and ballpoint pens. For us, time-sharing meant togetherness, a chip meant a piece of wood, hardware meant hardware, and software wasn't even a word."

Two deaths to report, with no details: **Charles H. Tavenev, Jr.**, of Boca Raton, Fla., on January 17, 1982, and **Edmund J. McClure, Jr.**, of Blasdell, N.Y. in 1983.

We hope to see you in Cambridge, Boston, or the Cape as we celebrate our 40th within the fortnight.—**Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

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Don Burke, in sunny St. Pete, says he's retired from the municipal bond business but is now running his own consulting and analytical writing show, interestingly called "BBBsNESS, Inc." . . . Had a nice telecon with **Jim Chabot**, who called to check **Norm Sas**'s whereabouts.

The Alumni Office supplied me with a couple of tidbits, including one about **Winchell Hayward**, who's worked for the San Francisco City/County since 1985. He develops electrical plans and spec's for projects for the water department and "Hetch Hetchy," which is a big dam in the Sierra from whence comes San Francisco's water. . . . **Morry Chomitz** is indeed alive and well and working for Day and Zimmermann in Philly. His kids are grown, and one got his letters in XVIII in 1975. Says he's enjoying center city living. . . . Sorry to find out that **Jim Church**, a course XIIIer who had lived and worked in the D.C. area, passed away some time ago—in 1983. . . . Keep them cards 'n letters flyin'.—**Jim Ray**, 2520 S. Ivanhoe Pl., Denver, CO 80222

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In September 1984 **Peter Saint Germain** was awarded the Bronze Beaver, the Alumni Association's highest award for service to M.I.T. This year Peter is the chairman of the Alumni Fund Board. He has been active in Alumni Fund and other fund raising for several years. As chairman of the M.I.T. Alumni Center of New York for the past three years, he convened a new advisory committee to initiate activities. Peter is a member of the Sponsoring Committee for the Economics Department, the National Business Committee, and the Corporation Visiting Committee for International Studies. He is an advisory director of Morgan Stanley and Co. in New York. . . . **Louie Rasmussen** added the job of executive vice-president to his responsibilities as chief financial officer of Kansas City Power and Light Co. . . . **Reginald Stoops** was appointed a visiting scientist at M.I.T. and will be working with the Materials Science Lab on studies of advanced composite materials, a field in which Reg is an independent consultant. He is part of the courageous syndicate for America Cup competition and is helping with the effort to reduce the weight of a 12-meter sailboat. This coming June is will be racing again with William F. Buckley, this time in the trans-Pacific competition.

Jules Levin continues with his work for the Los Alamos Scientific Lab in New Mexico. He had nothing new to report about his work, which is providing communication links on earth from signals received from space satellites. He made a personal trip to Greece, where he spent two weeks enjoying the sites of classical Greece. . . . **Dave Finnegan** is enjoying business success with his two-year-old firm that manufactures millwork needed for restoration of historical homes and buildings. A few years ago, Dave had theorized that after years of selling engineering know-how at fire-sale prices he needed a change. He wanted to market one of his many craft skills. He is now a consultant to the Providence Preservation and Historical Societies. He serves on their board, providing expertise on restoration of buildings. Business contracts from these and several other sources have brought Dave contracts to duplicate intricate and unusual millwork for mouldings, door frames, cabinets, and other applications. He is anticipating the need for a larger shop to handle his business volume.

Jim Manson writes that his "retirement business" has turned into an anxiety provoking activity, because with no review committees to face he tends to jump into things with both feet. But he finds it very satisfying. Under "better late than never," Jim is about to be granted his first patent, on the design of a special purpose x-ray source. Last spring he bid to build a soft-x-ray calibration unit for one of the National Labs. He won the bid and is actually fabricating what seemed so simple in the planning stage. Jim's unit will make it possible to change wave length without breaking vacuum in an application involving hydrogen fusion for energy generation. In order to house Jim's x-ray unit, he will have to provide a steel vacuum chamber and cryogenic vacuum pump.

Jim's wife Nancy continues to enjoy her work at the Concord Middle Schools, as well as the pleasures of having two daughters and six grandchildren within easy distance. Jim has taken up recreational sculling on the Concord and Sudbury rivers.

Gordon Pettengill has been appointed professor in the M.I.T. Physics Department. He will be director of the M.I.T. Center for Space Research. . . . **Elliott Bates** retired from his architectural firm in 1983, but continued as part-time consultant until May 1984. He has been doing some one-on-one tutoring and minor mountain climbing since then. . . . **Bill Wise** says, "Life as one retired from the corporate rat race continues to be most satisfying and the best career yet." . . . **George Brown** finds retirement satisfying, but he does occasional assignments in connection with design aspects of motor vehicle product liability claims. . . . **John Avallon** retired from GTE as president of the electrical products group. . . . **Sidney Crook** continues on the planning board in New London, N.H. He enjoys his restored 1928 Hackercraft speedboat. . . . **Peter Bolan** retired from the Power Systems Division of United Technologies. He has joined the U.S. Army Belvoir Research and Development Center as associate technical director.

Mark Kirchner is chief engineer of Aerodynamic Technology at Boeing Commercial Airplane Co. Mark was appointed to the Congressional Advisory Committee on Aeronautics. The committee will provide a balanced independent and objective assessment of Government-sponsored aeronautical programs. They will meet four times each year to review NASA aeronautics programs. . . . **Malcolm Reed** became a grandfather for the first time in November 1984. The baby was a boy, and Malcolm and his wife Barbara are enjoying their new roles. . . . **Alfred Murrer** retired as chairman of Gleason Works in Rochester, N.Y. . . . **Douglas Hutchings** is a stress project engineer responsible for structural analysis of Gruman's X-29 forward swept wing demonstrator. . . . **Ed Kosower** spent the spring of 1983 teaching a course that he took as an undergraduate. Ed was a visiting professor in the chemistry department at M.I.T. . . . **Jim Smith** is chairman, president, and CEO of Magnavox Government and Industrial Electronics Co. . . . **Charles Winnick** is with the Agricultural Technology Division of Exxon Chemicals. He has responsibility for technology licensing.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806, (401) 245-8963

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Orlien Becker has "semi-retired," which means he is very busy teaching and consulting. . . . **Archie Harris** sends his regrets for missing our 35th reunion last spring. He has recovered from the stroke that interfered with joining us and is active and lively again. We look forward to having Archie with us at other reunion events. . . . **Axel Kaufman** informs us that he continues to work as senior associate of Jung/Brannen Associates Inc., Architects.

Bill Kincaid has retired and is spending his time with four grandchildren and trying to "make a few bucks" in the stocks and bonds markets. . . . **Dwight Hibbard**, who has been the president and CEO of Cincinnati Bell, Inc. in Ohio, is now also the chairman of the board. Congratulations, Dwight. . . . **Walter Seibert, Jr.** would like to hear from classmates interested in AIME. Walter is the chairman of the New York section of AIME. He invites us to attend a monthly meeting. So, if you live in the area or are just passing through call Walter at (201) 833-0929.

Those who live in the Boston area and would like to sharpen your skills as an investor might enjoy signing up for courses taught by **A.W. Bigus**. Bigus teaches at the Boston Center for Adult Education and in the Brookline Adult and Community Education Program. He is the author of *Make Yours in Stocks and Bonds at Little Risk*. . . . Some classmates will be enjoying a mini-reunion with members of the classes of 1947 and 1948. The group will meet in Rhode Island in June. This is an earnest (desparate?) request for news of '49ers for publication in the *Review*; write or calll me or any class officer.—**Barbara F. Powers**, Secretary, 39 Mt. Vernon St., West Roxbury, MA 02132, (617) 323-1539

50 35th Reunion

The board of directors of the John W. Daniel and Co. located in Danville, Va. recently announced the election of **John P. Wall** to president. . . . **James C. McAllister** is presently director of telecommunications fo McDonnell Douglas Corp. His company is presently making the transition from an aerospace outfit to a company that will include the telecommunications business. Jim has been with them for 35 years come next July. Also, he and his wife took a super trip this year to Europe, Egypt, and Israel. Jim also tells us that he met **Helmut Weber**, who is retired from Penn State University and is teaching at a new job in San Diego.

We had just been informed of the deaths of **Ben Silver**, who died in 1982; and **Wilmer S. Garwood, Jr.**, who died on December 8, 1984. . . . Here's hoping to see you all at the 35th reunion in June to be held on campus and in Bermuda.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10H, Boston, MA 02114

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Aaron Brody reports, "Since moving to the Valley Forge, area in 1981, we have been active in the M.I.T. Club of Delaware Valley." Also participating is **Hugh Knipmeyer**, who lives in Wilmington and directs membrane R&D for duPont. "In October, I was elected a fellow of the Society of Packaging and Handling Engineers. In previous years, I had been elected fellow of Packaging Institute, USA and of Institute of Food Technologists. Thus, by statistical probability and by actual fact, I have become the only person ever elected fellow in these three professional societies, all of which focus on food and their packaging. And, to think that back in Building 20, I couldn't even spell packaging. Where have you gone, **Leon Hong**?" . . . **Melvin R. Rubin** is living in Lexington, Mass., where he commutes to Raytheon's Missile Systems Division in Lowell. . . . **Harry Harding** is president of Industrial Distributors, Inc., senior warden in St. Marks Episcopal Church in Halifax, NC, and is an instrument rated pilot of the Beech N58P Baron.

Victor Yancey reports that he is winding up his

Turning Them On in Junior High School

Some people think he's crazy, William Fitz-Gibbon, '56, says, for taking his M.I.T. degree to a junior high school teaching job.

But the results are pretty unusual.

Officials of the College Board say they know of no junior high school in the country, other than Walter Reed Junior High School in the North Hollywood section of Los Angeles, where significant numbers of eighth- and ninth-graders regularly pass College Board advanced placement tests in subjects such as physics, chemistry, and calculus.

Fitz-Gibbon gets credit from his students for a good part of this success, according to David G. Savage of the *Los Angeles Times*. But Fitz-Gibbon credits the students: "There's no way a regular junior high school can handle these kids," he told Savage.

The program began several years ago when Fitz-Gibbon, who studied general science at M.I.T., and two colleagues decided to try accelerating work for their most able and motivated junior high school students. It's been building ever since: "A good program breeds good students just like a good sports school breeds good athletes," Fitz-Gibbon told Savage. □

sixth term as president of the board of trustees for the local Rural Water Authority, providing public water to over 1000 families. And after being a member in a regional chapter of Society for the Advancement of Management for four years, he succeeded in founding a new chapter in Dayton, Ohio in November 1984. . . . **George Butzow,** chairman and CEO of MTS Systems recently was elected a director of Deltak Corp. in Minneapolis. . . . **J.D. Salveson** moved to Indonesia this January to manage the exploration and development of a new joint Chevron and Texaco geothermal project.—**Gregor J. Gentleman,** Secretary, 600 Holcomb, Suite No. 1, Des Moines, IA 50313

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Nick Haritatos has been working on a phosphate fertilizer project and a project for recovering metals from spent hydroprocessing catalyst at Chevron. Fertilizer proved fertile for promoting trips to Mexico and Brazil. He says he really enjoyed Rio de Janeiro and considers it one of the most beautiful cities in the world. Nick's son is a senior in high school, and his daughter is a sophomore, who is also with the San Francisco Girl's Chorus. . . . **Art Auer,** who practices vascular surgery near Saint Louis, traveled to Monte Carlo to give a paper last September, or perhaps gave a paper in order to travel to Monte Carlo. He then vacationed in Italy. He gave another paper in New Orleans in November, and planned to be in the British Virgin Islands just for fun in February. One of his sons is married, and another is a student at Washington University.

Howard Fawcett recently changed to the Westinghouse Machinery Technology Department in Pittsburgh from Lockheed Shipbuilding in Seattle. That sounds drastic to me. . . . **Gilbert Solitare** made an even more drastic change last spring by marrying Marlene Sabbath, a cytogeneticist and immunologist. Congratulations.

Some of us must travel vicariously, as **Cliff Sayre** may be doing. His daughter Elizabeth, '86, is taking her junior year abroad in Nantes, France. . . . **Sandy Isaacs** may be limited even in vicarious travel. His son Daniel is no further away than the Sloan School of Management. On the other hand his eldest daughter, Julia, is in graduate school in Berkeley, and his youngest child, Emily, is a freshman at Colby College in Maine, where her grandfather was once president. . . . In addition to watching the progess of his school-age sons, **Art Turner** is nurturing the progress of a brainchild, a nuclear cardiology gamma camera made by the division he heads at Baird Corp. He had the thrill of seeing it in the press coverage of George Schroeder's artificial heart transplant. It was used for pre- and postoperative examinations of Schroeder and other patients. . . . Best wishes to you in all your progress.—**Richard F. Lacey,** Secretary, 2340 Cowper St., Palo Alto, CA 94301

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To those of you with children who are graduating from high school or college this month, congratulations. You have reached another milestone on the road to "growing up" (which is better than getting older).

Bruce B. Hanshaw visited the South Pole on business last January and swam in Lake Vanda, which is in Antarctica. The swim was for pleasure, however, not business, if one can consider swimming in ice cold water a pleasure. . . . In November 1984 **Carl I. Swanson** was elected vice-president of quality assurance at Fenwal Inc. in Ashland, Mass. Carl has been with Fenwal since 1968, where he's held several engineering management positions.

Marty Wohl, who is still at Carnegie-Mellon University (according to the letterhead on his stationery) reports that both his children are now on their own, and so is he—his marriage of two years being in the process of dissolution. His fifth textbook, *Transportation Investment and Price Principles* (a little plug, Marty), was released this past November. Marty says he enjoys writing and teaching—"It beats working for a living!" Now that he's single again, Marty gives some advice on the relative ages of men and women at marriage (based on the late Elijah Muhammad)—the woman should be half the man's age plus seven years. I missed by two years, but we're still together after 31 years of marriage. Maybe there can be a question based on this in our next class survey in 1988. We can correlate relative ages with length of the marriage, although from our last survey, 84 percent are married to their original spouse.—**Wolf Haberman,** Secretary, 41 Crestwood Dr., Framingham, MA 01701; **Joseph M. Cahn,** Assistant Secretary, 289 Bronwood Ave., Los Angeles, CA 90049

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It is with great sorrow and regret that I report the death of **Dave Wones** in an automobile accident last December. Dave was an outstanding member of the class, both as an internationally respected geologist and as a continuingly active member of 1954. Since 1977, he had been professor of geology at Virginia Tech; he was chairman of the department for four years. Before that, he had been on the faculty at M.I.T. and had served as chief of the Experimental Geochemistry and Mineralogy Branch of the U.S. Geological Survey. He was widely respected for both his teaching and his research. Our sincere sympathy goes to his wife Connie and their four children.

Word has come (from newspaper clippings) that **Pasquale Di Napoli** is playing a major role in the restoration and rebuilding of the Statue of Liberty. He is with Ammann and Whitney, the New York engineering firm serving as principal contractor for the work on Miss Liberty, and is in charge of that firm's involvement in the project. I hope that all of the information above is correct. In the same batch of clippings that contained the above items were two clippings about one **Ed Eigel**. One quoted me as saying the exact opposite of what I had really said to the reporter. The other gave me a title and position at an institution that was far removed from the level and time of my actual brief association with the organization. In the former case, I had already written to the reporter, informing her of her error. In the latter, I have no idea where the information came from—I had never seen the article. In any case, my point is that the best source of accurate information is you. Let us hear about your activities directly. That will minimize the possibility of this column reporting things about your that are not true. It also will help make the column longer and more interesting.—**Edwin G. Eigel, Jr.,** Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.,** Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55 30th Reunion

We have a few notes this month which accompanied year-end contributions to the Alumni Fund. We would appreciate additional contributions cum notes, or even separate notes to your secretaries to provide more grist for our mills. . . . **Gary Brooks** reports that he has moved to the Big Apple (New York City for any of those not in the know) after some 13 years in western New England. Gary is now building the New York market for his firm, the Pace Consulting Group. . . . We have also heard from **John Farmer,** who advises that he was re-elected last November to a third term in the Vermont House of Representatives. John is presently on the House Appropriations Committee. Next stop, Congress?

John Lindenlaub advises that he spent the 1983-84 academic year on sabbatical at Worcester Polytech. He is now back to his duties as professor of electrical engineering at Purdue. He is also currently serving on the board of directors of the American Society of Engineering Education. John received the 1984 IEEE Education Society Achievement Award at last year's Frontiers in Education Conference. . . . **G.P. Maloney** tells us that he is currently the chief financial officer of American Electric Power Co., and that his wife, Dorothea, is an ordained Methodist pastor.

See you at the reunion.—Co-secretaries: **Marc S. Gross,** Winding Road Farm, Ardsley, NY 10502; **Allan C. Schell,** 19 Wedgemere Ave., Winchester, MA 01890

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Oscar P. Manley writes: "As head of the engineering research program in the Office of Basic Energy Sciences, U.S. Department of Energy, I am still tending this slowly growing program now in its sixth year. I also manage to make some contributions (one or two papers per year) to the mathematical theory of turbulence." . . . **Clark Weissman** was recently made general manager of the Secure Distributed Systems Division of SDC. This is a 100-people division solving complex problems of secure computing over communications lines for the Department of Defense and Industry. Clark has six kids, four currently in college in California. . . . From **Chris K. Van Peski** we get some advice: watch out when going thru Santa Monica; Chris is captain of the Santa Monica Mounted Police. In addition Chris is still vice-president at TRE Semiconductor Corp., was elected to city council of the Hidden Hills, and is serving as mayor pro tem.

Charles L. Kusik, who recently completed a national industry energy audit in the Philippines, predicts that an industrial energy conservation program could cut imported oil bills of the Philippines. Kusik, an industrial energy expert with Arthur D. Little, Inc., predicts that the program, launched in 1982 can prune some 32 percent from the country's trade deficit, and can pay for itself in under two-and-a-half years from its inception, in late 1982. The corrective measures involve off-the-shelf technology. This effort responds to an ongoing oil crisis faced by many developing nations and has excited worldwide interest in such national studies.

Terrance M. Carney writes that he is now director of Electrical Engineering and Computer Applications, Chattanooga School of Engineering, at the University of Tennessee. "Pretty strange for a reformed aero," he says. "My colleagues call me a lightly galvanized electrical engineer."—Co-secretaries: **Caroline Disario Chihoski,** 2116 W. Davies Ave.,Littleton, CO 80120, (303) 794-5818; **Robert Kaiser,** 12 Glengarry, Winchester, MA 01890, (617) 729-5345

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Martin Victor reports that he has recently joined the small, but inevitably growing, ranks of Class of '58 grandfathers. At the same time, he has moved yet again, this time to Victorville, Calif. (no relation, we presume) where he is commander of the USAF Hospital at George AFB. . . . **Arthur Alexander** is still at Rand Corp., where he is associate head of the economics department. He writes, "I am still continuing research on Soviet technology, but I am now also working on the U.S. versus Japanese trade issue."

Recently, **Paul Busch,** who is a vice-president of Technical Services at Malcolm Pirnie, Inc., was appointed a member of the Water Science and Technology Board of the National Research Council. Set up in 1982, the objective of this board is to address issues related to the management, development, and utilization of water resources in the U.S. . . . We are indeed sorry to report that **Daryl Wycoff,** who was so well-known to the class for his humorous cartoons in *VooDoo*, passed on in January. He had been a member of the Harvard Business School faculty since 1972 where he gained recognition as an authority on the railroad, trucking, and airlines industries. Over the past few years, he had visited China several times to evaluate and recommend improved transporation management techniques. In addition to his academic pursuits, Daryl had served as a director of Midway Airlines, Charles River Associates, and Rusty Pelican Restaurants. We shall all miss his great good humour and graceful spirit, and we extend our sympathy to Valerie Wyckoff and to their children.

Jorge Alfert is with W.R. Grace and Co. in Venezuela, where he is territorial manager for Venezuela, Columbia, and the Caribbean. He has been involved in the development and construction of several chemical plants in South America. Jorge and his wife Meara were among the international contingent at the 25th reunion. They have three children. . . . **William Thompson** is an associate professor of engineering science at Penn State University. He received his Ph.D. in acoustics from Penn State, after having obtained an M.S. in electrical engineering from Northeastern. He and his wife Martha have four children. . . . **Mortimer O'Connor** is with the Department of Defense at Fort Meade, Md., where he is managing a research and engineering organization. He and his wife Harriet have two children, and he is active as a CYO basketball coach. . . . Lastly, here's a spring offer you just can't refuse! If you've never had your name in lights in this column (you know who you are), give this month's issue to your wife and ask her to write a few words and send them along to us.

(Apologies in advance to the females and single males of the class, who will just have to write personally.)—**Michael E. Brose,** Secretary, 59 Rutland Sq., Boston, MA 022118

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Art Collias reports that he is president of a newly incorporated company, Mitek Surgical Products, which develops specialized surgical products for the niche marketplace, as the current jargon has it. Mitek's first product is a needle localizer for mammography. . . . **Calvin A. Campbell, Jr.** is the new chairman of Goodman Conveyor Co., Inc., the company he established in 1971, and chairman of Improved Plastics Machinery Co., a subsidiary. Goodman Conveyor has 200 employees and annual sales in the 20 million dollar range. . . . **Kenneth A. Wilson** reports that last September he started a new job with Brooks Automation in North Billerica, Mass. as manager of electrical engineering. . . . **Paul W. Todd,** a professor at Penn State, at least for a while, he tells us, will be making a transition into the directorship of a new biochemical center in Philadelphia. Paul's wife Judy received an M.S. last spring; his three sons are all in college; Clarkson, Temple, and Penn State Graduate School. Daughter Andrea is becoming a standout in regional gymnastics.

The inside story on Dr. **David F. Pawliger** is that he continues in his private practice in internal medicine, hematology, and oncology. He's also clinical assistant professor of medicine at the University of Florida. David's wife Harriett is a graduate student at the University of Florida, working on a master's in gerontology counseling. . . . **W.C. Guyker** reports his listing in the 43rd edition of *Who's Who in America*. . . . The *Wall Street Journal* of February 6, 1985 in an article on computers as language translators mentions **Chuck Staples'** company, Logos Corp. in Waltham, Mass. Logos is the developer of a German/English translator that the Journal counts as among the most sophisticated translating systems.

Harvard Business School professor **William L. White**, an authority on capital markets and the behavior of interest rates and co-author of *Money and Banking* and *The Financial System*, textbooks used widely by graduate schools of business, died in late January at Beth Israel Hospital in Boston. He was 47. Professor J.O. Light, a faculty colleague, was quoted in the *Boston Globe*: "Bill White's writing revealed his probing and questioning curiosity about the unexplained phenomena within financial markets—the patterns of corporate borrowing, the flow of funds, and the savings and investment process. He saw things about these phenomena that others took for granted. He wondered 'why,' and pushed others to wonder 'why' with him." . . . The undersigned has been appointed executive publisher for professional and reference, scientific and technical books at John Wiley & Sons, Inc. in New York, where he's held a number of positions since 1976.—**Myer Kutz**, Co-secretary, John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158

60 25th Reunion

It's reunion time! Among those planning to attend are **Charles Negin**, who indicates he is president of Grove Engineering, in Washington Grove, Md. . . . **Robert Lienhard**, who says, "I have been living in London for three years where I have held the position of chief executive planning for The BOC Group, a British based industrial gases company. I joined BOC three years ago after a long career with the Boston Consulting Group. I am returning to the U.S. in the spring of 1985 to become executive vice-president, Gas and Welding, The BOC Group, Inc., based at Murray Hill, N.J., with reponsibility for BOC's industrial gases activities in the Western Hemisphere" . . . and **Susan Schur**, who received the 1984 Honor Award by the National Trust for Historic Preservation, in recognition of her contributions to the preservation field, specifically for her work as publisher-editor of *Technology and Conservation*, an international quarterly journal founded by Sue in 1976.

Ronald Agronin, who became president of Wartsila-Appleton last September, and whose son Michael graduated from M.I.T. last June, and **Seymour Gordimer** have also indicated an interest in attending the reunion. . . . Colonel **Robert Troth**, who will be unable to join us, writes that he is finishing his third year at SHAPE in Belgium. His daughter Jeanne is a freshman at Wellesley, and his son Chris will start at Dartmouth this coming September. . . . **Bruce Kusse**, a specialist in plasma physics, has been promoted to professor of applied and engineering physics at Cornell University, where he has been a faculty member since 1971. . . . Hope to see you at the reunion!—**Noel S. Bartlett**, Secretary, 15320 Edolyn Ave., Cleveland, OH 44111

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The other evening **Tom Hastings** called to remind me of the upcoming 25th reunion next June, to solicit a gift for the Institute (and our 25th reunion gift) and to tell me some of the people he had been calling from the Bush room at M.I.T. had mentioned they occasionally read this column. I appreciate the notice and wish there were even more material for future columns. It isn't egoistic to write about yourself—just a favor to your friends. . . . **Peter Fishman** was married on June 6, 1984, to Gloria Chi. Pete still works at the N.I.H., "unraveling the mysteries of life. . . . **Terry Langendoen** was married last summer to Nancy Kelly, who is a psychotherapist in private practice in Brooklyn. . . . **Virgil Vickers** was widowed three years ago, but he and 8-year-old daughter Rani are "plugging along nicely." Virgil continues to work at Hanscom A.F.B. (in Bedford, Masss.). He says, "Computers are among the most fun toys ever invented."

Bill Lenoir left the astronaut corps to work for Booze, Allen and Hamilton as principal of space systems practice, and works in Crystal City, outside of Washington, D.C. The Lenoirs live in Great Falls, Va., just up the river from work. . . . **Reed Freeman** transferred to Union Carbide Europe, in Geneva, as vice-president. . . . **John Benjamin** spent 19 years at Inco but has moved to greener fields at Cabot Stellite. He lives in Kokomo, Ind., "until the new metal powder plant is complete." . . . **Robert Vickery** writes, "In 1978, I left a long and rewarding association with the McDonnell Douglas Corp. and, in 1979, co-founded SPARTA, Inc. In five years SPARTA, Inc., has grown to become a major contributor to our national strategic defense program. My wife, Joan, and son, John (16), have become firmly rooted in Southern California and we take full advantage of the year-round outdoor recreation as needed diversification from hectic professional schedules." . . . Also out in the sunny west are **Irwin Sobel**, his wife, Ceevah, and daughter, Sarah. They live in a new house in the Bay Area, where Irwin works for Hewlitt-Packard trying to improve electronics manufacture. This "is a switch from academia to industry" for Sobel. He finds it "interesting and very different." . . . Up the Coast a bit lives **Pete Gaposchkin**, who is programmer analyst for the Bureau of Management Information Systems—a department of the City of San Francisco. They use an I.B.M. 4341 which uses IDMS.

Last winter the Industrial Liason Program at M.I.T. sent me to Europe, to visit and give talks at some firms associated with the Institute. I was very flattered to be asked and enjoyed the trip immensely. I was struck by how well these industrial laboratories were equipped. It was rare to find instruments more than three years old (while we university types are happy with equipment less than a decade out of date). I was also struck by the vigor of the animal rights groups in En-

gland. The more militant "sects" break into laboratories, release the animals, and destroy experimental records. In reponse, the labs have turned very security-conscious, with elaborate measures taken at entrances and careful safekeeping of records. Leaving the lab at night becomes a half-hour undertaking: securing massive locks on all cabinets and sweeping everything off one's desk into locked drawers. A far cry from our slamming the door when we leave!—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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George E. Holz has made the news again, this time as a winner of the Frances Darne Award of the Society for Information Display. The award was given for the invention and development of a plasma display. . . . **Richard L. Horttor** writes, somewhat enigmatically, that he is still communicating with planetary spacecraft. That's not as bad as it sounds; my records indicate that he works at the Jet Propulsion Laboratory. . . . **Marty Klein**, whose name graces this column often, was recently elected to the Hall of Fame of Mount Vernon (N.Y.) High School. His company, which specializes in undersea search and survey, recently acquired Irad Gage Division of Creare Products, Inc., a New Hampshire-based manufacturer of geotechnical instruments. Marty is apparently seeing how deep high tech can go. . . . **Ted Sheskin** writes that after driving a 1967 Rambler American for over 17 years, he recently bought a new Renault Alliance.

Jeff Steinfeld has been named an assistant director of the George R. Harrison Spectroscopy Laboratory at M.I.T. Jeff's responsibilities include coordinating the scientific activities at the lab and maintaining communications among the personnel. . . . After 25 years **Dan Thornhill** writes that he finally admitted to himself that he may be around the Boston area for a while. He bought a house in Arlington and works for Intermetrics in Cambridge, a spinoff of the Draper Laboratory, which used to be the M.I.T. Instrumentation Lab in the days of yore. . . . **Warren Zapol** is an associate professor of anesthesia at Harvard-Massachusetts General Hospital. His research is on Weddell seals in the Antarctic, studying their swimming under ice with microprocessors, sampling blood, heart rate, etc.

Finally, I have the sad duty to report two deaths in our class: **Mohammad R. Damghany** and **William G. Margetts**. Mohammad returned to the U.S. from Iran two years ago and is survived by his wife and three children. William was co-owner and operator of a restaurant in Portsmouth, N.H.—**John E. Prussing**, Secretary, 2106 Grange Dr., Urbana, IL 61801

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Several letters from my overflowing mailbag spoke to whether they would send a child to the 'Tute. **Don Dreisbach**—teaching philosophy at Northern Michigan University in Marquette—says his first child, Tristan Ira, was born in September 1983, proving that us older folks can still procreate, "although having a younger wife (or husband?) helps." He recalls M.I.T. being too demanding, interfering with things like art and music, and prefered the time spent getting his Ph.D. at Northwestern, though Boston is more interesting than Chicago. He will discourage Tristan from going to the 'Tute. Margaret and **Tom Lewis** send very complimentary comments about this column's down-to-earth quality. (Thank you both.) They have sons Tommy, 13, and Jan, 9, who are into sports, piano (a family enterprise) and Sunday School. They live in Middletown, N.J. (6 Alpha Ct., 07748). Although he has never been an entrepreneur or manager, they are "content." Tom spent some time after graduation in the navy, then was with Prudential, Coopers and Lybrand, Blue Cross, Merrill Lynch, Bankers Trust, and now Bank of New York, mostly as a computer consultant.

Tom tells us **Charlie Einolf** got a Ph.D. at Rochester, then went to Sylvania, is now with Westinghouse in Pittsburgh, but spending time in Japan. Charlie's eldest (of four) goes to college next year; his wife is preparing herself to teach high school math. Tom's Burton roomy, **Hank Ziegler**, went right to Northrup in L.A., and is still with them, interrupted only by service as an officer in Viet Nam. Hank remains a bachelor; Tom wonders how many other never-marrieds we have.

Apparently most of us are second-time-marrieds, including **Roy Komack**, now of South Natick, Mass. (9 Countryside Rd., 01760). Lauren (they married in August 1982) is a psychiatric social worker. Son Andy is 14, living with his mother and "into heavy metal rock and roll and adolescence." Roy is now manager of design automation at Bose Corp. . . . **John Wawzonek** has been with Bose longer than Roy's 15 years. . . . **Dick Kirkpatrick** just left Bose to go with Setra Systems, Acton, Mass.

Anonymous comments from a self-styled grumbler: "Careerwise, all I got from going to M.I.T. was an inferiority complex." He has been 18 years with a large defense company, but has never been a manager nor senior staff member. He continues: "Career success depends only on knowledge gained in the workplace and on personal traits that no college can give you. Outstanding individuals have come out of M.I.T., but that's only because outstanding individuals have gone in." He will be neutral on his children going to the 'Tute.

From **Jonathan Gross**: "In 1973, I became the first custodial father most people had ever met, when all three children from my defunct first marriage stayed with me. My cooking improved immensely. . . . " His eldest is a computer-science major at Columbia. Jonathan's now remarried, to Susan, a speech therapist; they have two children together. He enjoys sand sculpture on Cape Cod and jogging.

I'm planning to leave the state agency at which I do my lawyering, probably for the private sector, on March 26; I'll keep y'all informed. Don't stop writing, now that you've got the habit.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218

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Greetings from an airplane between Boston and Washington, D.C. Over the last month and for the next two, I'm a three-to-four day a week commuter while working on a short-term planning project between two of the company's facilities. No real complaints, though—the restaurants in the Washington area are superb. The only real risk with the commuting is in flying over Baltimore where **Alan Gamse** resides. After his last name was misspelled in the February/March column (because of my negligent proofreading), Alan might choose to take pot shots at the airliner I'm riding in. Sorry, Alan!

The news in this issue comes from Alumni Fund contributions. **Steve Schlosser** writes that he is enjoying "retirement" from the class secretary chores. He notes that the kids and family are okay and that life is interesting and exciting. Business travel has Steve spending a lot of time in and around Los Angeles. Given the ice storms that hit the Washington area in the winter, that might not be such a bad deal. . . . **Leonard Parsons** was a visiting professsor at INSEAD, the European Institute of Business Administration in Fontainbleau, France during the fall of 1984. According to my 1984 *Alumni Register*, this would have involved taking leave from his teaching position at the Georgia Tech College of Management. Comment allez y'all? . . . Nancy and **Ken Ekstrand** are the proud parents of Eric Maxwell Ekstrand, born October 20, 1984. Ken, only one question. As a Course VIII grad, the choice of your son's middle name is understandable, but where does the Eric come from?

Jack Downie is a partner with the firm, P.L. Stubbe, Inc. in Titusville, Pa. They are manufacturers' representatives for plastics industry equipment. Jack, his wife Darlene, and their daughters, Adrienne and Michelle, "love the Northwestern Pennsylvania area." . . . Another note from Pennsylvania comes from **David Manchester**. He is now president, CEO, and part-owner of the J.E. Baker Co., a producer of industrial refractories throughout the U.S. David coaches soccer and hockey "on the side" in York, Pa. while he and his wife Connie "try to raise a 14-year old daughter and a 12-year old son." . . . Please send news of yourselves, families, jobs, etc.—**Joe Kasper**, Secretary, 1100 Salem St., No. 103, Lynnfield, MA 01940

65 20th Reunion

Two notes bring reminders that our 20th Reunion is coming. The reunion committee has worked hard, and all are looking forward to a good turnout. **J.D. Roach** writes that he is looking forward to the Reunion and is celebrating by trying to make 1985 a spectacular year. . . . **Ed Hoffer** says that he is tired of signing receipts (as class agent) and wonders if I want to be agent for the next five years. (No thanks. I'll let someone else raise funds for the 25th reunion gift.)

Raymond Fisher writes that he and Sally have three children, Amy (12), Brian (5), and Matt (2). Ray works at G.A. Technologies in La Jolla, Calif. He is manager of a small group of physicists developing new applications of the plasma diagnostics that they developed as a result of their fusion energy research. . . . **Peter Gerstenberger** is chairman of the Berwick Group, Inc., a management consulting firm that he cofounded with several colleagues from Arthur D. Little, Inc. in 1976. Peter and Maureen live in Andover, Mass., with their children Susan (15) and Peter Chris (3). . . . **Richard Amster** was married last July 6 and joined the Yankee Group as director of communications research in August. Richard and wife have returned recently from a round-the-world trip including six weeks on their own in China.

Peter Brown is still trying to modernize the U.S. Navy's amphibious ships. Peter says that he has tried aircraft, rapid transit, and now naval engineering careers and that it's hard to tell what's next. . . . **David Crawford** was promoted to director of purchasing last September for Galion Manufacturing Division of Dresser Industries. Last summer Dave discovered the joys of whitewater rafting on the Gauley River in West Virginia. . . . **Eric Westerfield** is now manager of electrical engineering at Adept Technology, a robotics company that he describes as a two-year-old start-up. . . . **George Moyer** has been transferred to Los Angeles by Citicorp.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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Is the geographical center of our class shifting westward? Where (who) is the geographical center? Any speculation or definitive answer will be received with great interest. . . . **Andy Skibo** reports that the Skibo family's slow westward migration has finally brought them to California, although it does not appear they followed any of the more famous "Westward Ho" trails of the last century. Following M.I.T., Andy and Leslie lived five years in Springfield, Mass. (where Andy worked at Monsanto) and ten years in Greenville, S.C. (where he was with Daniel International), before finally moving to the San Francisco Bay Area two years ago. Other than suffering from mortgage-induced culture shock, they have adapted well to the native lifestyle. Their three Southern boys—Zak, 9; Nick, 6, and Jedd, 4—provide the excuse for Dad to act like a kid in

public. Daughter Byrn, a California girl, was born last June. Andy moved to the Bay Area to join Genentech, where he holds the position of director of Engineering, Facilities, Purchasing and Administrative Services. He reports that Karen and **Bill Dix** have their second daughter, Emily, born last November. They and Katie, almost 5, live in the Denver area, where Bill is with Gulf Oil/Chevron's oil division.

Bill Klecan writes that he is still in Miami and recently saw **Pete Kendall,** who is working in the Bahamas. . . . Jo Ann and **Stephen Flaum**'s second child, Russell Isaac, was born last summer. . . . **Gerald Siegel** is a senior manager with Peat, Marwick, and Mitchell in Short Hills, N.Y., where he is managing a consulting practice in information systems development. . . . **Ross Corotis** won the ASCE Walter L. Huber Research Prize for 1984. . . . **Roy Gamse** is director of marketing for MCI Telecommunications Corp. He and Joyce have two children, Nicholas, born December 31, 1982, and Laura, who was born October 5, 1984 after 9-1/2 months of pregnancy and a mere 70 hours of labor.

Richard Rush is completing his first book, *The Building Systems Integration Handbook,* a 450-page handbook for architectural professionals. . . . **Yi Hu Ma**'s daughter Vivian is a member of M.I.T.'s Class of 1988. . . . **David Mechler** changed jobs in April 1984 and has shortened his commute from two-and-one-half hours to 30 minutes. He is now with Emery Air Freight in Wilton, Conn., where he is overseeing development of personal computer software to be offered as a value-added service to large industrial clients. He was previously with GTE Telenet in New York City. . . . **Fred Hottes** must lead a hectic life—his twin girls arrived in February 1984, just in time to supervise the construction of their new home. . . . **Ken Anderson** reports that he is recovering from a long illness and hopes to be looking for work in the near future.—**Jim Swanson,** Secretary, 878 Hoffman Terr., Los Atlos, CA 94022

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Joanne and I were pleasantly entertained by Sina (Mrs. **Tom) Najarian**'s sparkling piano performance at Sander's Theater at Harvard. Six hundred enthusiastic patrons heard Sina perform with cellist Edward Gulabyan. A concert at Symphony Hall is in the works for October 1985. Bravo! . . . **David Matheson III** writes that he is still enjoying the challenges of entrepreneurship and is now in the third year of building a software consulting services firm. David has three children (12, 9 and 4) and for the past five years has coached youth league soccer. . . . **Kathryn K. James** writes from Missouri: "After fighting a religious discrimination battle against the U.S. Army, I was finally promoted to GS-13 in September. I am now working on requirements for state-of-the-art army tactical intelligence systems." . . . **Thomas Moebus**, an industrial liason officer at M.I.T. since 1981, is now assistant director of the Industrial Liason Program (ILP). He will be in charge of all the ILP activities in Europe. . . . **Randall J. Hekman** is author of *Justice for the Unborn* (Servant Books, Ann Arbor, 1984). A dramatic review of this book recounts how Michigan probate court judge, Heckman, "refused to authorize an abortion for a 13-year-old who was five months pregnant and wanted one in August 1982." Judge Hekman recounts his persecution and attempts to disbar him that followed, his eventual vindication by judicial peers and by the 13-year-old girl. Heckman constructs his view of how "abortion on demand" evolved from judicial events almost 200 years ago. It is certainly an absorbing but controversial work.

T.C. Cheng, professor of electrical engineering at the University of Southern California, has been named Lloyd F. Hunt Professor of Electrical Power Engineering there. He has been director of the university's electric power program since 1980. . . . **David Lyon** writes "Enjoying living in San Diego and the work at M/A-Com Linkabit. Currently heading development and product line management of small satellite earth stations—'Personal Earth Stations.' " . . . **Robert Harrington** reports that he has entered the venture capital industry as a general partner in the Los Altos office of MBW Venture partners. . . . **Paul David Epstein** for the last few years has been helping to run New York City's productivity improvement program. His book, *Using Performance Measurement in Local Government: A Guide to Improving Decisions, Performance, and Accountability* has just been published by Van Nostrand-Reinhold with a forward by San Francisco mayor, Dianne Feinstein. . . . **Stanley J. Sramek** is presently working as a geophysicist at Texaco, Inc. in Houston.

The December 1984 issue of *Science Digest* lists "America's 100 brightest scientists under 40," and our class has two of its own in the list. (We knew we were good!) Astrophysicist **Marc Davis** at the University of California at Berkeley has been working on the large scale structure of the universe, basically the distribution of galaxies. He has also been one of those proposers of the "Nemesis" stellar companion to the sun explanation of periodic mass extinctions. And **Ray Hagstrom**, a high energy physicist at Argonne National Laboratory, apparently is a whiz at developing unique instrumentation: "I borrow from, improve, or modify industrial developments to create unique instruments." He has looked for free quarks with a device borrowed from ink-jet and laser printing technology. . . . **Alan Goldberg** recently "joined the landed gentry of northern Virginia." He works for Perkin-Elmer on the space telescope scheduled for an August 1986 launch. Daughter Rebecca is 8 months old. . . . Well, that's all folks—until dramatic new developments in the next issue of these notes. Ad Astra!—**Eugene F. Mallove**, 215 Highland St., Holliston, MA 01746

70 15th Reunion

Thomas J. Garrity is currently director of marketing of Elanco Product Co., a division of Eli Lilly and Co. . . . **Arthur Davidson** and family are preparing for a six-month stay in Denmark at the Technical University of Denmark, where he will be visiting professor in the Physics Department. After that, he will return to I.B.M. in Yorktown Heights, N.Y. . . . **James Fong** is with the Mining and Metals Division of Bechtel Engineering and Construction Co. in San Francisco and has recently completed and presented to the coal ministry of the People's Republic of China estimates for a coal slurry capital project. . . . **Bob Fleischer** and his wife are expecting their third child. . . . **George Salas** is general manager at Computer Sciences Corp. of Venezuela.

Herb Stevens has received a Master of Law and Taxation degree and is a partner in the firm of Lane and Edson in Washington, D.C. He is also adjunct professor of law at Georgetown University. . . . **Ronald Abramson** is practicing law in New York. . . . **Mike Bromberg** is consulting under the name Three-Ring Circuits from his hilltop residence in Mason, N.H. He has finished climbing the 100 highest peaks in New England and is working on the Colorado Fourteeners next. . . . **Earl Withycombe** is in the middle of his second term as county supervisor of Sierra County, Calif., and has survived three elections by 15-vote margins and several recall attempts. He has now started an air pollution consulting business, Sierra Air Consultants, and has gained the nickname "Landslide." He and his wife have four daughters. . . . **Wayne Porter** is continuing his busy practice in dermatology in North Miami Beach and is president of the Miami Dermatological Society.

Peter Kramer is doing biophysics for Johnson and Johnson and he and his wife have two children. He is also publishing Apple software with Edutech. . . . **Sydney Jackson** married Kathy Rink in Los Alamos, N.M. . . . **Edward Macias** is professor of chemistry and acting chairman of the chemistry department at Washington University in St. Louis. . . . **Stephen Cooper** writes that he and his wife are awaiting another baby. . . . **John Hurt, Jr.**, is assistant professor of pathology and laboratory medicine at University of Texas Medical School in Houston. . . . **Paul Burstein** is alive and well and living in Winchester. . . . **James Leary** is associate professor of pathology at the University of Rochester Medical School. His wife is a computer engineer at the laser fusion facility, and they have two children.—**Robert Vegeler**, Secretary, Dumas, Backs, Salin and Vegeler, 2120 Ft. Wayne National Bank Bldg., Ft. Wayne, IN 46802

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Janet Koch writes, "Nothing much is new: Still working for the World Bank as an economist in the energy department; travelling to Manila, Philippines, for geothermal and petroleum projects (exploration and development) for which I am responsible; and working on projects in Hungary. Between travel and work, I try to do some bicycling and just plain enjoy Washington, D.C., as a place to live." . . . **Randall E. Moore** announces the birth of David Shaw Moore on May 21, 1984. . . . **Del Hillgartner** is an account executive with Audio Visual Workshop, New York, N.Y. . . . **Robert H. Price** writes, "Got married to the former Connie D. Abreu; moved from Livermore Laser Fusion program to become project leader for Trailmaster at Los Alamos Lab; and built a new house on the road to the ski hill in Santa Fe, N.M."

Harold H. Nussbaum writes, "I am almost halfway through a two-year term as a voluntary worker for the Mennonite Central Committee, working in peace education here in Miami." . . . **Mike Gilmore** is now division chief in charge of all deputy attorneys general assigned to the Idaho Public Utilities Commission. . . . **Andrew Lippman** now holds the NEC Career Development Professorship of Computers and Communications at M.I.T., where he directs the Architecture Machine Group in the newly formed Media Laboratory. He has made important contributions to the field of interactive computer graphics, including work on the development of frame-buffers graphics and optical video discs and he has been involved in the creation of a new field, computational video. He received his S.M. in computer graphics from M.I.T. in 1978.—**Hal Moorman**, P.O. Box 1808, Brenham, TX 77833-1808

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Paul Karger is starting a Ph.D. program at Cambridge University in England. He says, "I'll be working on computer security sponsored by my employer, DEC, and particularly by my boss, Steve Lipner, '65." . . . **Seth Cohen** writes, "Our son, Mark was born October 21. His sister, Rachel, is delighted." . . . **Alan J. Morrow** has been appointed development associate, ceramics at the Corning Glass Works. . . . **Fred Fruitman** writes that he has joined the venture capital firm of E.M. Warburg, Pincus in New York. "Marnie and I are the proud parents of Laura Fruitman, born June 25, 1984."

Michael J. Rowney was promoted to senior vice-president of finance for MCI Telecommunications. He completed his first marathon, the Marine Corps Marathon in November. . . . **Faruq Ahmad** reports, "Involved in the fast-paced arena of deregulated telecommunications, living in San Francisco, my favorite city." . . . **John Krzywicki** reports, "Baby number two due May 30. Just gave seminars in office automation in Hong Kong, Singapore, Taiwan, Korea, and Japan. Morris team toured England in May."

Lou Clark completed his master's in computer science at the University of Colorado in January

and has a job with Bell Communications Research in New Jersey. . . . **Steve Henry** has become a partner in the Boston Law Firm of Cesari and McKenna and an adjunct professor of patent law at Suffolk University Law School. . . . **Alan Michael Cooper** writes, "My wife, Liz Mumper M.D., and I moved to Lynchburg, Va. in July, where she has joined a pediatric group and I am clinical administrator, psychiatry at Virginia Baptist Hospital. . . . **Brad Billetdeaux**: "Susan and I just celebrated surviving one year in Houston and find that we are really enjoying the Southwest—no winter, large house. At work I am trying to couple the best of operations research and end user computing." . . . From **Carol Epstein**: "Am enjoying being back in the Big Apple and being a business woman. Am going to New York University part-time for an M.B.A. Also skiing and kung-fu. Visited Boston briefly and was touched to see the dollar bill around the cashier's office. The only change is that *King of Hearts* isn't in Central Square."—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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Sherry Horn Kesden practices ophthalmology in Massapequa, N.Y. with her husband, Dennis. Michael (6) and Cindy (3) keep her busy. . . . **Nicholas Hamisevicz** announces the birth of Victor on December 4. . . . **Mike Gregory** was just elected as chairman of the math and computation section of the American Nuclear Society. . . . Martin and **Cynthia Stratton** had their second son, Justin, last April and are finding two to be a handful. When free, Cynthia practices law at home and works in the family business. . . . **Paul Green** is manager of engineering services for Stratus Computer. Marty and Sarah live with him in their new solar house in Harvard, Mass.

Joel Bergman is systems analyst for a Southern Cal Edison nuclear plant. He is also the L.A. Kings correspondent for a New York hockey writer. . . . **Steve Warsof** is assistant professor of obstetrics/gynecology at Eastern Virginia Medical School. Another child is due in March to join Beth (2). . . . **Joe Hadzima** is a lawyer with the Boston firm of Sullivan and Worcester. . . . Christine and **Stuart Goldman** have a new daughter, Alexandra, born in October. . . . **Bob Klein** is a partner in the law firm of Piper and Marburg in Baltimore. Bob and his wife Trisha have a daughter, Morgan, and twin sons, Patrick and Evan. . . . **Paul Boinay** was board certified in cardiology and will become an A.C.C. fellow this spring. . . . **Paul Raber** received a Ph.D. in anthropology from Penn State. . . . **Randy Stern** is vice-president of research and development for Kurzweil Computer in Cambridge. . . . **Lee Perrin** is an anesthesiologist at St. Elizabeth's, Boston. The Perrins have two children, Andy and Jennifer. . . . **Jim Silverman** is in the tax department at Touche, Ross, in Pittsburgh.—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Mary Anne McCarthy writes that her three children—Betsy (4), Mary (2), and Susan (3 months)—and her husband, Mike, (currently a lieutenant-commander in the U.S. Navy, assigned to Boston) are all doing well. . . . **Fred Shapiro** recently became the father of Andrew Garry Shapiro (November 23, 1984). He says that he will probably wait a few years before teaching him "the only useful thing that I learned at M.I.T.: the game of tiddlywinks." Fred is at New York Law School as a law librarian (head of reference services) and assistant professor. . . . **Stephen D. Fantone** has become a fellow of the Optical Society of America, for showing exceptional insight and inventiveness solving both theoretical and practical optical problems in gradient-index media, holography, aspheric optical systems, optical coatings, and optical polymers." . . . **Edwin Arrippol** has been living in Milan for three years, expanding his family's empire in the import/export business. He says that he would be pleased to see anyone passing his way.

Andre Jaslom and his law partners at Stecher, Jaslom, and Pritzman are doing well and having fun at the same time. (Can things like litigation and corporate counseling be fun?) Andre, his son, Peter (almost 2 years old), and his wife, Janet, are also having fun. . . . **Richard Booth** was promoted in 1984 to engineering program manager at Harley-Davidson. . . . **Paul Schindler's** newspaper (*Information Systems News*) became a magazine last January, and he became the senior west coast editor. His new daughter Rae was born last October. . . . Stephen Glazier is an attorney in Washington, D.C., specializing in real estate with the firm of Wyman, Bautzer, Rothman, Kuchel and Silbert. He offers a choice piece of property to serious buyers in hope of reducing the national debt: by appoint only, 1600 Pennsylvania Avenue.

Bill Orchard is a senior financial analyst at Hollister Corp. in Libertyville, Ill. . . . **Benjamin Svetitsky** is back at the Institute working at the Center for Theoretical Physics with, he says, "the profs who scared me the most." . . . **Howard Herzos** and his wife had a new daughter, Anne Sara, last year. Howard is director of sales at Aspen Technology, down the street from M.I.T. . . **Roser White** and his wife, Sue, and kids—Heather, Altair, and Roser, Jr. (new in 1984)—have two faithful dogs and a houseboat on Lake Powell. . . . **Abbe Sue Rubin** is a senior biostatistician at G.D. Searle and Co. in Skokie, Ill.—**Jim Gokhale**, 45 Hillcrest St. Arlington, MA 02174; **Lionel Goulet**, 21 Melville Ave., Dorchester, MA 02124

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Carrie Galehouse has left Bain and Co. to become director of sales at Softbridge Microsystems Corp., a start-up software firm in Cambridge. . . . **Dan Fairweather** finished his M.B.A. in August 1984. He is now quality control auditor for new product development at AC Spark Plug in Flint, Mich. Dan and his wife, Mary, live near Lapeer, Mich., with their 3-year-old daughter, Becky, and their 2-year-old son, Joe. . . . **Sarkis Koltookian** married Ruth Mary Ruff on November 17, 1984. Whit Halstead, '78, and Dave Wiederspahn, '78, managed to make it to Iowa from the east and west coasts for the ceremony. Sarkis is still working on his 1961 Corvette project and designing John Deere tractors. . . . **Steve Aaronson** has started a software and systems consulting business for design and development of micro and mini-computer systems.

Walter Goodwin completed law school in Detroit, graduating summa cum laude, and spending the last term as editor-in-chief of the law review. Walter is now in Omaha, Neb., working in commercial and banking law. Walter also mentioned that Dr. **Leigh Wattlington** is completing her OB/GYN residency in Detroit. . . . **Darryl Jordan** sent a short note: "Finally entitled to three weeks vacation at ARCO. Playing computer games with all free time. Too busy."

Hamid Moghadam co-founded AMB Investments, Inc., in San Francisco in 1983. AMB specializes in real estate investment management and development. Hamid is the "M" in AMB. . . . **Todd Glickman** is chairman this year of the American Meteorological Society on broadcast meteorology. Todd is still doing weekend weather on 50 stations nationwide for Weather Services, Inc., and during his spare time, (Monday-Friday), is manager of new product development at WSI Corp. . . . Please drop me a note soon.—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO 80907

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Those of you who read *Science Digest* know that it recently ran a major story, "America's 100 brightest scientists under 40." Our representative to that distinguished group is **W. Dan Hillis,** cofounder of Thinking Machine Corp. of Cambridge, Mass. Dan is a computer architect who, according to SciDi, is working on "bursting through the 'Von Neumann bottleneck'—limitations imposed by the traditional architecture of one main processor and memory bank—in devising a new supercomputer called the Connection Machine." The computer will avoid the bottleneck by using between 64,000 and a million high-speed processors. Dan calls the new machine "a tool for studying intelligence." . . . **Frances Scovil,** spent four "wonderful months in Barcelona, Spain on an exchange program with a business school there." Frances is now finishing her M.B.A. at the University of Chicago, and by the time you read this will undoubtedly have completed her "search for the perfect job." . . . **Jeff Vandegrift,** last I spoke to him, was living in the far boondock suburbs of Boston. Now, he's left his position in medical imaging equipment at CDA and has become a consultant in software and systems.

Most people write about their jobs or their families. **Rob Milne** writes about the mountains he has climbed. Rob spent spring of last year in the Himalayas of Pakistan and did the first ascent of a big rock peak. Read about it in the May, 1985 *National Geographic*. . . . **Steve Piet** sent us a note from Idaho about his July wedding to Robin Ramsthaler; **Mark Bye** was an usher at the wedding. For their honeymoon Steve and Robin travelled to both Germanies, Austria, and Czechoslovakia. . . . As of February, 1984, **Bill Lull** "left the world of consulting engineering and started an architectural engineering/CAD software company." He's doing some independent consulting on the side as well. . . . **Richard Brudnick** writes that he is "founder and stockholder in Videotick, Inc., rapidly on its way to being a major electronic publishing and services corporation." He adds that he is also active in operating the "James Brudnick Co., a fast-growing health care distributor in the New England area (whose name bears a curious resemblance to my own.)" . . . I thought he was in Chicago, but **Larry Yablong** writes that he is "still living in New York City." He's now working at Merrill Lynch Capital Markets as an investment banker. "The job has more zip and excitement, plus I get to go back to Chicago for free." . . . Also in the Big Apple is **Bruce Nemlich,** who was recently made supervisor of analytic services at the New York office of the international consulting firm, McKinsey's.

Steve Stein is a resident in emergency medicine at the Medical College of Pennsylvania. From there Steve will shortly move on to work for the National Health Service in St. Albans, Vt. Steve writes that he just attended the weddings of **Michael Manes** and **Bill Fejes** (not to each other). Mike will be working for the National Health Service Corps in Alabama. . . . **Jill Phelps Kern** writes that she "recently accepted the position of management sciences consultant with D.E.C. in Stow, and will also be a lecturer in operations research in Northeastern." . . . If you're looking for a car in the Montclair, N.J. area, look up **Eva Lerner Lam,** now the general manager of Regency Motors (Volvo, Jaguar, and Rolls-Royce). . . . Also an expert in transporation, **Bernie Alpern** has joined U.R.S. Co., Inc., a consulting engineering concern. Bernie will start by performing anlayses of transportation needs and problems on the New Jersey side of the George Washington Bridge.

We have three new babies to report. **Kathy Hardis Fraeman** and husband Marty ('73) announce the birth of their daughter, Dora Helen. "She's just started to sleep through the night, so I'm starting to feel almost human again. All in all, I'm finding out that parenting is really quite wonderful, even though sleep becomes a much-

missed commodity." . . . **Cindy Lou Husman Berman** and hubby Hal ('76) just had their first, named Kim Melissa. Cindy writes, "Because of her long slender fingers, many predict that she'll be good at a computer keyboard." I prefer to think she'll be a great basketball center. . . . When **Ron Dictor** wrote, his second child was due any day, so our congratulations to him. Other good news for Ron is that he finished his chemical engineering doctorate at the University of California, Berkeley, and is now working in General Motors' Research Lab in Warren, Mich.

A big move to the sun-belt for **Nayyar Butt**—from the wilds of White Plains, N.Y. in IBM's marketing department to Dallas, where he is an instructor in IBM's Marketing Education Center. . . . And speaking of big moves, **Don Lampe**'s law firm (Akin, Gump, *et al* of Dallas) have shipped Don out to their London office. . . . **George Ortov** sent a short note from the suburbs of Chicago. George has been directing a construction quality verification program for Commonwealth Edison's Braidwood Nuclear Station. . . . Unfortunately, I could hardly read **Loren Greenfield**'s note. From what I could piece together, Loren just recently completed work on the 550-room Weston Hotel, O'Hare in Chicago. He's now working for a Chicago real estate syndication, "but no need to fear—I am not *yet* a [unintelligible] slumlord."

This month I received one of the best newsey letters I've gotten since starting on this job. It's from **Steve Kirsch**: "After getting S.B. and S.M. degrees in electrical engineering and computer science from M.I.T. in January 1981, went to work for ROLM Corp., designing office systems software. After nine months, discovered that I hadn't changed the world so I quit; spent three months skiing; spent two months trying to get a job *interview*. Couldn't even get a job interview, so started my own company in July 1982. I called it 'Rodent Associates.' In January 1982, we had four employees and had delivered our optical mouse product. We changed the name to Mouse Systems. In January 1985, we had over 50 employees and sales of about $1 million a month. We were ranked No. 5 on the '*PC Week* Softsel Hardware Hotlist.' Our mouse appears in IBN's PC Jr. TV ads. We also market a 'paint' program with our mouse."

Well, for the news of the mere mortals, there's me. (Yes, I know that the news of my meager existence makes all of you feel better by comparison. That's my job.) Last column I hinted of upcoming good news—namely yet another twist in my mercurial career. Alas, it was not to be. I'm still fighting the good fight, trying to cut hospital costs for Blue Cross of Massachusetts, and gaining a better understanding of the word "futility."

Speaking of futile, it's awfully hard to write these columns without news. So, I'm now recruiting *you*. You can do any of three things: send me news of yourself—this will help correct the lies other people tell me about you; send me news of other people, preferably true, but speculations and even non-slanderous fiction may even be acceptable; volunteer (what any ugly word) to be an associate class secretary (ASC). The job of ASC is to gather gossip in your area and report it to me, or even to write part or all of a column. It's easy, it's fun, and it's a good chance to get even with me for all the nasty things other people have reported about you. Just send your news or letters of enlistment to me.—**David S. Browne,** 50 Follen St., No. 104, Cambridge, MA 02138, (617) 491-5313, work: (617) 956-2214

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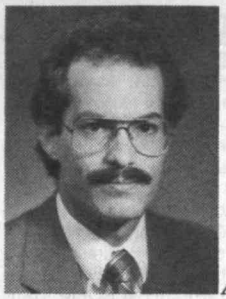
Mary Jeanne Packer-Gaiotti writes, "I'm still in the U.S.D.A. Forest Service, at the Green Mountain National Forest in Rutland, Vt. I do most of the transportation planning (the best way to get logs from the tree to the sawmill), manage a human resource program geared toward women employees (yes, there are even fewer women at the



A. L. Robinson, '79

Forest Service than at M.I.T.), and work with the rest of the engineering staff to help them learn how to use new Data General 4000 equipment that all national forests in the country have acquired. I married a fellow employee, a forester named Richard Gaiotti. We have a three-year-old son and are expecting another baby in April. We designed and built a solar-heated greenhouse addition two years ago, which has been a real help in our cold winters. We have a flock of about 30 mixed breed chickens and are in the process of clearing some of our wooded land to make a sheep pasture. All in all, Vermont is great—any former classmates are always welcome. I still hear from **Helen Rueda**. She works for the Forest Service, too. Right now she's in Baker, Ore., the Wallalla Whitman National Forest. Paul Kimball, '77, passed through the neighborhood the summer before last on the Appalachian Trail. He's still in Huntington Beach, Calif., with Rockwell International. I heard from Allan Peevers, '82, another old 5th West buddy, last winter. He was just starting at IBM in greater New York City at more $K than he was years old!"

Peter DeForest is with Bank of America in San Francisco and was promoted to vice-president in September. He recently visited some Sloan School friends while on a business trip to London and Amsterdam. . . . **Phil Stein** is an NIH postdoctoral fellow at Harvard. . . . **David Strauss** was married last Labor Day weekend to Susan Rounder (Wellesely, '79) in Philadelphia. Attending the wedding were **Dan Nathan, Jon Glaudemans,** Tom Faust, '80, Steve Oliva, '80, Jeff Tyrrell, '80, John Tyrell, '43, Chuck Markham, '81, Jim Wilber, '81, Roger Renshaw, '77 and his wife Joan Hughson, '77, Dan Higgins, '77, John Piotti, '83, and David Crane, '82. New husband David will be finishing the Wharton M.B.A. program this May.

David Holt was married to Pam Morgan (Wellesely, '81) last August, and went to Maui and Kauai for a honeymoon. . . . **Andrew Robinson** has joined the General Electric Research and Development Center in Schenectady, N.Y., as an electrical engineer. Andrew and his wife reside in Schenectady as well.

That's all for this month. Where are the rest of you? Please drop me a line soon. Certainly you've done at least *one* worthwhile thing in the last six years!—**Sharon Lowenheim,** Secretary, 303 East 83 St., Apt. 24F, New York, NY 10028

80 5th Reunion

I regret to report that our mailbox was empty this month. We're looking forward to seeing everyone back at the 'Tute for our 5th reunion.—Co-secretaries: **Ken Turkewitz**, 11 Academy St., Arlington, MA 02174; **Debra Utko**, 18A Congressional Circle, Flying Hills, Reading, PA 19607.

81

Ahem! This month's column starts with a message from our class president. Okay, Lynn, you're on:

"Our 5th reunion is only a year away, and it is time to start planning the grand event! We need your ideas and assistance to make this happening truly extraordinary!! Previous reunions have included cookouts, clambakes, harbor cruises, brunches, Cape Cod outings, Pops concerts, etc. However, it might be fun to plan some less traditional events as well. That is why we need your suggestions and help. Please write and let us know what activities you would enjoy. Also, if you would like to help make the arrangements, especially if you are living in the Boston area, your time and effort would be greatly appreciated.

Please send all reunion correspondence to: Lynn Radlauer, 2 Soldiers Field Pk., No. 315, Boston, MA 02163."

Jonathan Griep writes that last summer he left his job at Honeywell in Minneapolis to become a staff CMOS design engineer at Fairchild Semiconductor in South Portland, Me. Jonathan's wife, Martha, '80, left Sperry to also work at Fairchild as a CAD engineer working at Standard Cell software. Jonathan and Martha bought a house last fall in Scarborough and have been busy ever since fixing it up, their pride and joy being a newly renovated bathroom. Jonathan writes, "Portland is a much more cosmopolitan city than I ever thought it would be. With its proximity to Boston, we have been enjoying it quite a bit. We try to get down there at least once a month. I even got to some of the VLSI lectures on Tuesdays."

Connie Bear is married to Randy Thompson and is living in Heath, Tex. Connie's working as an applications engineer for USDATA. . . . **Julie Neuringer** is in her fourth year of medical school at Brown. (A previous column mentioned that she was done.) . . . **Nora Fong** is finishing up (fourth year) at New York University School of Medicine. She plans to specialize in ophthalmology. . . . **Mitchell Brook** is completing his final year at the University of Pennsylvania Law School. He'll be joining the firm of Fish and Neave in New York following graduation.

Richard Heller is in is second year at Harvard's Kennedy School of Government. Richard spent the summer working at the U.S. Department of Commerce, International Trade Administration, analyzing American competitiveness in the computer peripherals industry. . . . **Paul Marcus** is now living in Boston and is working as the director of development for the Chiofaro Co. . . . **John Dellea** graduated from Boston College Law School in May 1984 and passed the Massachusetts Bar. He currently works as a law clerk for the New Hampshire Supreme Court. . . . **Anitta Bliss** went to Egypt in June—planned the whole trip. Anitta says that it was "quite an adventure." She's "not been the same since." Sounds wonderful. . . . As for the rest of you, let's hear about your adventures.—**Charles Markham,** Secretary, 362 Commonwealth Ave., No. 2E, Boston, MA

82

Tony Carpentieri writes that he's working at PG&E in northern California. He's also working occasionally ("very occasionally," he says) on his master's. Tony was best man at **Noel Hsu**'s wedding. Noel married **Janice Joachim** in Toronto, where he's working on his Ph.D. at the University of Toronto. Tony also writes that **Mark Donelly** is working on his chemical engineering master's at the University of Delaware. . . . **Joseph Pasquale** is pursuing his Ph.D. in distributed systems performance at the University of California, Berkeley. . . . **Bob Powell,** writes, "After a fantastic one-year vacation at Microsoft in Seattle, I'm back in Cambridge, working/living at LISP Machine, Inc. with the rest of the 'Senior House of Software' gang." . . . **Kevin Hazel** writes that he has "grown fat and ugly." (Isn't it nice to get honest news from your classmates. If Kevin can write to tell us that, the rest of you can write to tell us anything. *almost*.) . . . **Shirley Susan Koppel** writes that she is working at Edwards AFB, California for General Dynamics as a flight test engineer on the F-16. . . . **Todd Chase** is managing electrical engineers at IBM in Poughkeepsie, N.Y. As of last October, Todd passed wedding anniversary No. 2. (Us swinging singles have a blissful life of spinsterhood ahead of us to look forward to!)

Dave Harrahy is having fun windsurfing and scuba diving in Hawaii. (I'm beginning to hate people who live in areas with a nice climate and write me to rub it in!). Anyway, Todd says, "Work on the submarine is difficult and challenging, but the western port visits are fun and exciting." . . . **Rick Cohen** is pursuing my life dream by playing keyboards for a Boston-based rock band, The Stores. Best of luck to you, Rick, and let me know where you're playing so I can come cheer for you! . . . **Michelle Gabriel** is working at Motorola in Phoenix in the RF (Radio Frenquency) Assembly Department. Michelle went on vacation last summer with **Elena Rozier**. They drove though Arizona to Durango, Col. . . . **Victor Quintana** is also working at Motorola. Victor was married last spring to Donna Wu. They are now the proud parents of a baby girl, Laura. Last October, Michelle and Elena attended a Baker House reunion in Las Vegas along with **Mark Vershel, Ricardo Sitchin, Pete Lemme, Jill Shirley, Jack Martin, George Kahn, Steve Vaughn,** and **Julie Foster**. They all went to see female impersonators and gambled till they dropped. . . . Hope all is well with the rest of you, but I guess I'll never know until you write!—**Rhonda Peck,** 38 Bigelow St., Cambridge, MA 02139

83

Greetings from lovely Dallas, Tex. . . . **Hans Grieser** sends a little note that he is engaged to a very pretty girl from Wheelock College. He was introduced to Jean Marie Magoson by **Terry Sutton,** his former lab partner. Who said that labs were not worthwhile? Congratulations, Hans. . . . Let's all have a round of applause for **John F. Piotti**. John finally graduated, however, not before receiving the International Balfour Award for the most outstanding graduating senior. . . . **Aline McKenzie** (legally dropped her last name of Jones) is currently working as a salesclerk in a china shop. Aline is also working towards her master's in neuroscience at the University of California, San Francisco, specializing in auditory physiology. McKenzie is a little easier to say than Eucalyptus.

John Kowtko expresses interest in establishing a Bay Area Chapter of the "I hate **Eric Johnson** Fan Club." John says he would be happy to do anything to promote the destruction of Eric's credibility. John has recently moved to the Bay area because he could no longer take elements of the New England winters. He is currently doing software counsulting involving Unix/C, CAD, and personal computers, and his first assignment is in Tokyo, Japan. John sends news of other classmates. . . . **Peter Kalish** is officially engaged and should be married by the time you read this. Peter met Kathy in Idaho Falls while doing thesis work in EGG nuclear engineering. Rumor has it that Pete will begin working for GE in Schenectady, N.Y. Congratulations, Peter. . . . John has been in contact with **Gary Oliverio**. Gary has recently purchased a condo and is living in the electronic life-style. . . . **John Shim** is in his second year of medical school at Syracuse. Shim extends an open invitation regarding suggestions for a Korean wife? . . . **Steve Isakowitz** is working for Booze Allen in Washington, D.C. Steve is headed towards the alter very soon. According to John, Steven and Monika are like Velcro strips . . . if you try to pull them apart they make a lot of noise. . . . **Mark Seidel** is living in Acton, Mass. and his working for Lincoln Labs with his wife Katia. . . . **Eric Cigan** has settled in Belmont, Calif. with his wife Ellen. Eric is currently working for Lockheed. . . . **Brian Jacobs** is also in the area but working for Raychem in Menlo Park.

Judy Bergwerk is a product engineer at Valid Logic Systems in Silicon Valley. Judy also tells us that **Jeff Kletsky** and **Eric Schrader** gave a "Bakerite" type party one weeking. **Shi Shi Lui** and other personnel showed up. **Cady Coleman,** who is supposed to be getting a Ph.D. at UMass, Amherst, could not fathom the idea of not showing up for such a gaylor event. . . . **Glenn Eaton** is currently working for ROLM Corp., which has since been acquired by IBM. In preparation for Big Blue, Glenn is acquiring another wardrobe consisting of dark suits and white shirts. He will attend business school in the spring after skiing two weekends per month this winter. Glenn also sends news about several members of our class. . . . **Ali Borhan,** Glenn's roommate in chemical engineering is working towards his Ph.D. However, Ali is still his old self, playing volleyball, soccer, assorted racquet sports, skiing, and still finding time to "knock them dead" at Stanford. . . . **Rachel Cotter** is also working at ROLM, coincidently in the same department as Glenn. Rachel has found a new love, besides Glenn, skiing. . . . Crusty **Tom Duffy** is pursuing his master's in electrical engineering at Stanford. Tom spent last summer working for Intel, checking out a mask defect detector. . . . **Karl Levy** finally joined us in the real world by getting a real job. He is currently working for Intel in Portland, Ore. Karl spends most of his time surveying a semiconductor fabrication plant. . . . **Mark Lamey** is back in his hometown in Portland, Ore., working with his friend Don McGavin for a chain saw manufacturer. . . . **Steve Johnson** is working for NCR in Colorado Springs. Steve is planning a volcano climbing trip to Mexico in the spring.

Agnes Huang is currently living in Stanford, Calif. and working for Watkins Johnson in San Jose. She married David Kane, '82, in September. Dave is still working for his Ph.D. in electrical engineering at Stanford. . . . **Denise (Brush) Roberts** got tired of Wicheta Kansas but not tired of her husband Jim. Togeter they moved to Seattle, Wash. were they both work for Boeing. Convenient. . . . **David Shumway** is currently in navy submarine school and will serve on the *U.S.S. Hyman* (no joke) *G. Rickover*, which is based in Norfolk, Va.

Philippe Kletzkine is currently with the French space agency, CNES, and working at the Guiana Space Center in French Guiana (South America) within the European Ariane Space Booster program. . . . **Theodore Ordman** scratched down some message about recovering from a broken ankle. Apparently he obtained the fracture while in the process of falling off a ladder? Hope you feel better soon, Theodore. . . . **Charles Gardner** writes that he is involved in establishing his own TV/electronics sales and service business in his hometown in New York state.

When I really need gossip, I walk upstairs to my informant, Kathleen Harragan, '82. As you all recall, Kathleen is president of the New York chapter of the "I Hate Eric Johnson Fan Club." Kathleen always has the real juicy tidbits for me. According to Kathleen, Katia and **Mark Seidel** will be expecting their first child. By the time this article is printed, Katia should be well into her fourth month. Congratulations, you two. Kathleen says that **Dave Craigmile** is currently attending Northwestern Business School and has agreed to open up a Chicago chapter of the "I Hate Eric Johnson Fan Club." Dave has also agreed to begin working on his own elite club called the "I Hate Ronald Reagan Fan Club." Dave, is this really true?

On a much more serious note, I must tell all of you some bad news about one of our class members. **Jack Link** died on October 29, 1984, from very serious injuries sustained in an accidental fall. Jack, a one-time associate news editor of *The Tech* worked for Hewlett Packard as a software development engineer. Jack obtained his injuries while investigating some equipment problems on the roof of the hospital. I had a great deal of contact with Jack when I was UAP. I know I speak for all of us when I say that we will all miss him . . . God Bless You.

As for myself, I am still going to classes every other month in Dallas. I am still competing in track and hopefully will play rugby or lacrosse this spring. I am still looking for a place in New York. The next time I am home for more than two consecutives weeks I will begin an active search. Keep the letters coming.—**John E. De Rubeis,** Secretary, 47 Gillette Ave., Sayville, NY

84

I received a press release announcing that John Piotti had been seletced as the winner of the 1984 Balfour Award, "Sigma Chi'a highest honor bestowed upon an undergraduate member." That's very nice and we congratulate John. But it raises a point, for John—though he graduated in June 1984—entered with and considers himself a member of the Class of 1983. The press release came to me because the Alumni Office bases its classification of alumni on the date of graduation, unless a change is requested. John has since asked for such a change, and he's now officially a member of 1983. Others who want to make a change—even members of 1983 who have enough good sense to realize that '84 is superior in all respects to '83—can do so just by writing or calling the Alumni Office, indicating a desire to "reaffiliate." It's all very simple.

I received an early Christmas card from **Ken Freedman,** former class vice-president, followed by a "surprise" phone call. After chatting for two and a half hours, I learned that Ken, who graduated a year early, had received his M.S. from Stanford, had learned to program a computer and shortly thereafter published a paper on the computer modelling of the kinetics of the fertilization process of sea urchins (Ken made the remarkable discovery that either only 19 percent of the area of the egg is available for fertilization or only 19 percent of the sperm are capable of fertilizing the egg, noting that "the two alternatives are mathematically indistinguishable"), moved to Philadelphia, and is currently applying to medical school. Ken was insulted when he learned that the Alumni Office had classified him as a member of the Class of '83; our former class vice-president stated that he proudly wears the (superior) '84 class ring, and would rectify the Alumni Office's error immediately.

I bumped into **Rich Cowan,** former class president. Rich is finishing up his fifth year in the 6A Co-op program, working for GE in Schenectady, N.Y. In the spring, Rich will return as a 6.001 TA; he plans to finish his thesis over the summer and then work.

I received a long letter from **Tom Chen,** who entered M.I.T. with the Class of '83 but who has since then repentantly declared his allegiance to our class. The purported intent of the letter was to "cheer" me up; the letter attempted to fulfill its purpose by listing all of Tom's lamentations, bemoaning Tom's supposed "terrible mistake" of leaving M.I.T. in order to attend graduate school at UC Berkeley. I later spoke with **Mona Wan,** attending graduate school at Stanford, who reported that Tom was doing fine. When I told her of Tom's depressing letter, she claimed that he "just likes to complain" pointing out that Tom was playing tennis regularly and was, in general, enjoying himself.

M.I.T. Update: Despite some controversy over the demolition of willow trees, Amherst Alley has finally been reconstructed, three months behind schedule. With little fanfare and almost no publicity, the M.I.T. skating rink has reopened, boasting a brand new skate rental service, the class gift of the Class of '84; despite the lack of hype, the skate rental has been predictably successful. The latest fad (at least at Baker House) is "jane-ing," alternatively referred to as "doing jane." About 20 people gather every night (in the fourth floor lounge) to participate in this activity. No, it isn't illegal (wich is surprising, since almost everything is illegal in Massachusetts); these hardcore enthusiasts are just doing Jane Fonda exercises.

Please note that I have moved once again, this time into Ashdown House (511B). I cordially invite all class members in the area to visit. I wish you well and bid you to wear that Brass Rat proudly?—**Peter Tu,** Secretary, Ashdown House, 511B, M.I.T., Cambridge, MA 02139

I CIVIL ENGINEERING

Martin Wohl, '53, and **Chris T. Hendrickson,** Ph.D.'78, both faculty members at Carnegie Mellon University, are co-authors of *Transportation Investment and Pricing Principles* (John Wiley and Sons, 1984, $49.95). It's a study of the economic issues that govern transportation—demand, risk, effective return, marginal costs, and the like—written especially for transportation engineers who have traditionally had little knowledge of economics. The result of their unfamiliarity? Inefficiency and waste, say Wohl and Hendrickson, which the new book may help to eliminate.

Professor **Rafael L. Bras,** Sc.D.'72, and head of the Water Resources Division in the department at M.I.T., is co-author of *Random Functions and Hydrology,* published by Addison Wesley. The text gives an advanced-level view of the tools of random processes and field theory as they are applied to the anaylsis and synthesis of hydrologic phenomena.

Mark A. Turnquist, Ph.D.'75, has been named associate dean for computing and computer-related issues at Cornell University's College of Engineering, Ithaca, N.Y. The position will extend through June 1986. Turnquist joined Cornell's faculty (Department of Environmental Engineering) in 1979; his area of expertise is in analysis and design of transportation, mainly through the use of computers. . . . **William S. Reinhardt,** S.M.'83, is currently employed as operations manager of George C. Hall and Sons, Inc., a heavy construction contractor. . . . **William J. Roberds,** Sc.D.'79, writes, "Employed as senior engineer with Golder Associates, Seattle, Wash., an international consulting firm that investigates nuclear waste disposal."

Jean-Bernard Caen, S.M.'81, reports that he has been appointed marketing manager of the French subsidiary of Comsharf, Inc., a computer software company. . . . **Jon Hagstrom,** S.M.'65, director of research and vice-president of CBI Industries, Plainfield, Ill., has been named a Fellow of the American Society of Mechancial Engineers (ASME). Hagstrom's interests focus in the area of design of metal plate structures for nuclear power plants, refinineries, and chemical plants. . . . Also, the ASME has elected **Frank B. Kaylor,** S.M.'61, chief engineer of the Environmental Engineering Division at Stone & Webster Engineering Corp., Boston, to serve on the 1985 National Nominating Committee. Kaylor has published more than 100 technical papers and reports, and has been active in ASME in the air pollution, environment, power, energy, and transportation areas.

II MECHANICAL ENGINEERING

Joseph Harrington, Jr., Sc.D.'30, a consultant at Arthur D. Little, Inc., Cambridge, and to various government agencies, is the recipient of the *American Machinist*'s 20th annual AM Award. Harrington was cited for "perceiving computer integration as the key to the factory of the future, helping foster its implementation, and contributing to the understanding of the essential nature of manufacturing," as stated in a press release announcing the award. . . . **Andy Vasilakis,** S.M.'68, has left AMTI in Newton, Mass., where he was one of six principals, to return to his former employer, Tecogen Systems, Waltham, Mass., as manager of engineering. "Now I can get involved in many facets of Tecogen modules: engineering, servicing, and applications," says Vasilakis.

Two alumni in the department have been named as Fellows of the American Society of Mechanical Engineers: **James P. Johnson,** Sc.D.'57, professor of mechanical engineering at Stanford University, as well an international authority on turbulent shear flow; and **David K. Felback,** Sc.D.'49, professor of mechanical engineering at the University of Michigan, Ann Arbor, and a specialist in fractography and metallurgical failure analysis. Felback studies high-performing graphite-epoxy composites.

III MATERIALS SCIENCE AND ENGINEERING

Jerry D. Plunkett, Ph.D.'61, president of the Montana Energy Research and Development Institute (MERDI), has been appointed the first vice-chancellor for research and technology at the University of Denver, Col. Plunkett founded MERDI on a $15,000 grant in 1975; it now has an annual business volume of $12 million. He was also one of the founders of the National Center for Industrial Innovation. . . . **Samuel W. Smith,** Sc.D.'81, is currently Assistant Professor of Ocean Engineering at Florida Atlantic University.

Peter Tarassoff, Sc.D.'62, was a 1984 Extractive Metallurgy Lecturer of the Metallurgical Society of the AIME. . . . **Edward S. Sproles, Jr.,** Sc.D.'76, has been promoted to supervisor of Connector Evaluation and Reliability at AT&T-Bell Laboratories, Columbus, Ohio. . . . **William J. Harris, Jr.,** Sc.D.'48, vice-president of the Research and Test Department at the Association of American Railroads, Washington, D,C., has been named a Fellow of the American Society of Mechanical Engineers. Harris has also more than 30 years experience with metals and materials and with public policy relating to science and technology.

V CHEMISTRY

John A. Rollino, Jr., Ph.D.'69, reports that in the fall of 1984 he accepted a position as professor of chemistry and physics at Upsala College, East Orange, N.J. . . . **Clifford L. Creel,** Ph.D.'76, is currently serving as president of Savant Corp., Houston, Tex. . . . **John T. Funkhouser,** Ph.D.'54, former director of Arthur D. Little, Inc.'s Center for Environmental Assurance, has been named vice-president and manager of the firm's Los Angeles office.

Edward S. Macias, Ph.D.'70, acting chairman of the Department of Chemistry at Washington University, has been named chairman of the Committee on Nuclear and Radiochemistry of the National Academy of Sciences/National Research Council. . . . **Kenneth D. Jordan,** Ph.D.'74, reports: "Presently, I am on leave from the Chemistry Department at the University of Pittsburgh, and am spending the year as the program director for theoretical chemical physics at the National Science Foundation."

Gerald B. Kasting, Ph.D.'80, is presently involved with new drug development at Procter and Gamble. . . . Professor **Mark Wrighton,** in the department at M.I.T. and **Jack Hallgren,** Ph.D.'72, a chemist at General Electric, have each been named one of "America's Top 100 Young Scientists," as reported in the December 1984 issue of *Science Digest.* Wrighton has been able to mimic the process of photosynthesis in a photoelectro-chemical solar cell that converts water and carbon dioxide into energy-rich fuels. This device will become "more attractive if carbon dioxide levels increase, as predictions of the 'greenhouse effect' indicate they will." Hallgren expanded a long-term interest in silicone into a large-scale research effort to improve it, developing a new family of non-corrosive silicone sealants that can be used in industrial capacities or in the home.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

From **Gordon S. Brown,** '31, former head of the department and dean of engineering who has retirement homes in Grantham, N.H., and Tucson, Ariz.: "**Arthur Porter,** '39, who was a Commonwealth Fellow from England at M.I.T. from 1937-39, was honored last year by being made an 'Officer of the Order of Canada.' The investiture was conducted with pomp and tradition by the Governor General of Canada at Rideau Hall, Ottawa. This is quite an honor, and we congratulate him."

Tsen-Chung Cheng, Sc.D.'69, professor of electrical engineering at the University of Southern California, Los Angeles, has been named Lloyd F. Hunt Professor of Electric Power Engineering. Cheng, who has been director of the university's electric power program since 1980, oversees $2.5 million in sponsored research. . . . **Amos E. Joel,** S.M.'40, a switching consultant at AT&T Bell Laboratories, Short Hills, N.J., has been awarded the 1984 Columbian Medal from the city of Genoa, Italy. Joel was recognized for his work in telecommunications switching in the United States and for his role in the planning of the world's first system using stored program control.

Thomas C. Warner, Jr., S.M.'47, writes, "I have just retired after 25 years with the University of New Haven (Conn). I was chairman of the Mathematics and Mechanical Engineering Departments, and Dean of the School of Engineering (1965-1976)." . . . **Laurence R. Swain,** S.M.'60, has been promoted to senior vice-president of Datacon, Inc., Burlington, Mass. Swain's responsibilities include the European Division (in Germany) as well as the Eastern and Midwestern Divisions in the United States. . . . Assistant Professor **Raphael Lee,** Sc.D.'80, in the department at M.I.T.; and **Richard Greenblatt,** Ph.D.'74, a computer researcher with LISP Machine, Inc., have each been named one of "America's Top 100 Young Scien-

Can a $36 million office building fit comfortably into Boston's architecturally sensitive Back Bay? The picture shows the answer of Richard J. Bertman, B.Arch.'60, a principal architect of 399 Boylston St. (center)for Childs Bertman Tseckares and Casendino, Inc., architects of Boston. The new building—and the contiguous 8-story Warren Chambers Building (left), restored by CBT as part of the project—will "serve as an anchor to a renewed commercial vitality in the Back Bay." Bertman's "overriding objective," he says, "was to preserve the contextual character of the Back Bay along Boylston Street." The lower part of the building is of traditional Back Bay materials—brick walls and limestone details. But the upper part, higher than most Back Bay buildings, "relates to the sky . . . scaleless and made of reflective glass," says Bertman. (Photo: © Steven Rosenthal)

tists," as published in the December 1984 issue of *Science Digest*. Lee also holds a faculty post at Harvard University (in plastic surgery). Lee is studying how cells and tissue grow and remodel in response to external stress and hopes to eventually "grow" cartilage, blood vessels, and tendons in the laboratory from patients' own tissues. Lee is a MacArthur fellow. While at M.I.T. Greenblatt began the group that was responsible for the design of the first integrated hardware and software for LISP systems. LISP—one of the most sophisticated computer languages designed to run only the most sophisticated computers—is capable of dealing with symbolic data. Greenblatt is also known for his earlier work (1966-67); he designed the first computer chess program to compete in tournaments with humans. How did it do? "Oh, we won a few games," he says.

VI-A INTERNSHIP PROGRAM

This spring, 216 Course VI sophomores applied for entrance into the VI-A Internship Program. Although lower than last year's 228 applicants from a slightly larger class, this was 1.5 percent more of this year's sophomore class.

This year—for the first time—the EECS Department has applied quotas on how many VI-A's companies may accept. We are trying to bring the program down to a manageable total of about 250. The last few years, with pressure from students and companies to grow, it has been running between 290 and 300. This year's entering class should number between 90 to 95, rather than the 104 taken a year ago. A final report will be given in the July issue.

Our annual business meeting, dinner, and company open house were held on March 4, 1985. All 22 participating companies were represented. There were 107 faculty advisors and company representatives who attended the annual dinner and heard an after-dinner addresss by Robert K. Weatherall, director of M.I.T.'s Office of Career Services and Preprofessional Advising. Over 300 attended the annual VI-A company open house, which followed in the Sala de Puerto Rico.

During the two following days, the companies conducted a total of 1,034 interviews, which again taxed M.I.T.'s physical facilities. We spread out as far as the Bush Room and Building 24 to find enough space, and also converted two small kitchenettes for the interviews.

Each year, we are pleased to note a growing number of VI-A alumni/ae who return to interview for their companies. This year was no exception, and we had the following: **Steven L. Bates,** '74, for GenRad; **William R. Bidermann,** '78, for Digital; **Dean R. Collins,** '58, for Texas Instruments; **Chester M. Day, Jr.,** '57 and **Neil M. Haller,** '58, for Bellcore; **Nancy M. Hartle,** '82, for Honeywell Electro-Optics Division; **Mark E. Huntzinger,** '82, for Codex; **Glen Kramer,** '83, for Schlumberger/Palo Alto Research; **Theodore M. Lyszczarz,** '74, for M.I.T. Lincoln Laboratory; **Vincent Palmero,** '83, for Honeywell Electro-Optics Division; and **Eric A. Slutz,** '74 and **Alan Snyder,** '73, for Hewlett-Packard Laboratories. It was great to see them all and hear of their progress within their organizations.

The VI-A Office continues to enjoy the visits of many of its graduates. Stopping by since our last writing were: **Jeffrey M. Blacksin,** '82, with Digital; **Richard W. Chin,** '80, here on the recruiting team for Hewlett-Packard Computer Systems, Cupertino, Calif.; **Karl M. Lofgren,** '75, a manager with Western Digital, Long Beach, Calif.; **Juan C. Mercier,** '83, with Hewlett-Packard Computer Systems, Cupertino, Calif.; **Lynn M. Roylance,** '72, with Hewlett-Packard Laboratories, Palo Alto, Calif.; and **John A. van Raalte,** '59, with RCA Sarnoff Laboratories, Princeton, N.J.

Also, the director met with **Lawrence Kernan,** '76, who works for Index Systems, Inc., with offices in Kendall Square.

Finally please note, the EECS Department has announced the opening of a new position—associate director, VI-A Internship Program. This will be an administrative staff position, reporting to the director of the 68-year-old program. If anyone is interested, or knows of someone who might be, the VI-A Office will be most happy to mail out a detailed job description upon request. Call: (617) 253-4644, or write.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 02139

X CHEMICAL ENGINEERING

Martin L. Yarmush, a principal research associate in the department at M.I.T., has received one of the first 16 Markey Scholar Awards to support his studies in immunology and biochemical engineering. The award provides $500,000-$700,000 in support over six to eight years.

Lee P. McMaster, Sc.D.'69, has been promoted from business manager to vice-president/general manager of engineering polymers and fabricated products at Union Carbide Corp., Danbury, Conn. . . . **Willam K. Fraizer,** S.M.'80, writes, "After five years at Chevron Research, I am now a senior chemical engineer with the Production Department of Chevron U.S.A. in Ventura, Calif. I am assisting with planning and preparation for the construction of new oil and gas processing facilities to handle production from our large offshore discoveries." Also with Chevron is **Marc Machbitz,** S.M.'78, who reports, "By the time this is printed, I should have been transferred back to Chevron's home office in San Francisco." . . . **Charles L. Kusik,** '59, an industrial energy expert for Arthur D. Little, Inc., Cambridge, recently completed a national industrial energy audit in the Philippines. Kusik predicts that industrial energy conservation can cut some 32 percent from the country's trade deficit.

Doug McConnell, S.M.'42, writes, "Now retired in California but I do get to New York and to our favorite island, Antigua, West Indies." . . . **Jim Lago,** S.M.'47, vice-president for process research and development at Merck & Co., Inc.,

Rahway, N.J., has recently retired after more than 37 years of service. . . . **David Rubin,** Sc.D.'75, reports, "Employed by Exxon Research and Engineering Co., Florham Park, N.J. Returned earlier this year from a one-year assignment on the Cerrejon Coal Project in Colombia, S.A." . . . **Michael Jon Kell,** S.M.'72, received a Ph.D. in Biophysics/Anatomy (1984), from Emory University, Atlanta, Ga.

XIII OCEAN ENGINEERING

F.A. Packer, Jr., '51, writes, "Am entering my third career—becoming a high school math teacher. I've been taking certification courses at Kean College of New Jersey.". . . **Jerome J. Fee,** '67, director of navy ship design, transferred to project manager for the acquisition of cruisers. . . . **Frederick R. Haberlandt,** S.M.'78, re-located to SuPShip, Groton, Conn., in December 1984; assigned to the SSN688 class submarine new construction.

XIV ECONOMICS

Professor **Paul Samuelson**'s best-selling text, *Economics,* has a co-author for its 12th edition, just out: Professor **William D. Nordhaus,** Ph.D.'67, of Yale. Samuelson explained in the *New York Times* that "I had to decide whether to let it gradually die. I felt I owed it to the book not to." Nordhaus is no stranger to readers of economics; he made regular appearances until recently on the *New York Times* financial pages.

Donald Ratajczak, Ph.D.'72, is currently director of the Economic Forecasting Project at Georgia State University, as well as director of Morgan Keegen & Co., Inc., Memphis, Tenn. . . . **Raymond E. Willis,** Ph.D.'64, reports that he is "professor of management, School of Management, at the University of Minnesota. Spent the 1983-84 year on sabbatical leave, teaching at the Universities of Lyon and Rennes in France. Named chairman of the Department of Strategic Management and Organization on July 1, 1984." . . . **Dave McClain,** Ph.D.'74, writes, "Still at Draper Laboratory, and living on Draper Ave., Arlington, Mass. Some things don't change."

XV MANAGEMENT

What will happen when people enter the totally electronic office of the future? For an answer, read *Information Payoff: the Transformation of Work in the Electronic Age,* by **Paul A. Strassman,** S.M.'55 (Free Press, Macmillian, 1985, $20.75). His presumption at the beginning, says Strassman, who is vice-president of Xerox Corp.'s Information Products Group, is that "computers are the single most important technological means for assuring the future growth of society's productivity." The goal of the book follows from that: "to show how information technology can alter job design, organization forms, and social influences in such a way that all combine to create a workplace which is much more productive and satisfying than we have today."

Melford E. Monsees, '58, is coordinator of Missouri Graduate Engineering Program in Kansas City, and also an associate of Richard Muther and Associates, Inc., consulting engineers. . . . **William O. Schach,** S.M.'50, has been named senior vice-president of Merrill Lynch, Pierce, Fenner and Smith, Inc., Pittsburgh . . . **Ronald J. Zlatoper,** S.M.'75, writes, "As a captain in the Navy, I am now serving as the military assistant to the secretary of defense, Caspar W. Weinberger." . . . **Sven A. Wehrwein,** S.M.'80, writes, "Still enjoying the intensity and stimulation of investment banking and New York City. As a vice-president in corporate finance, I recently left Dean Witter to share in the explosive growth of Drexel Burnham Lambert." . . . **Leonard M. Lodish,** Ph.D.'68, has been elected chairman of the Marketing Department at the University of Pennsylvania's Wharton School.

SLOAN FELLOWS

Neil R. Vander Dussen, S.M.'70, is president of consumer products and president of the U.S. marketing division of the Sony Corp., New York City. . . . The Eastman Kodak Co., Rochester, N.Y., has announced two appointments: **Merrill L. Doxtader,** S.M.'71, manager of Manufacturing-Equipment, Consumer Products Division; and **Robert W. Camp,** S.M.'66, manager of Manufacturing-Materials, Professional Photography Division. . . . **Richard J. Howe,** S.M.'65, has been promoted from group vice-president of communications to executive vice-president at the Pennzoil Co., Houston, Tex.

Richard E. Brackeen, S.M.'75, has recently been promoted from vice-president of business development to deputy general manager, Space Launch Systems, Denver Aerospace, at Martin Marietta Aerospace.

MANAGEMENT OF TECHNOLOGY PROGRAM

Erick Chaum, S.M.'84, visits the Management of Technology Program office periodically to keep us up-to-date on his company—10 Point Systems. As president, he is managing the finishing touches on the prototype system, finding test markets, and looking for capital. In January, he took his second business plan to potential investors and received very positive feedback. . . . Our other entrepreneur from the class of 1984 called at the end of January to report his product is going well. **David Hite** was still in Nashville working on distributorships for his software package for the construction industry. He had two lined up, and reported his sales strategy was to "sell it like a construction tool, not like software." David will be moving back to the Washington, D.C., area.

We had our yearly recruiting visit from **Carol Lemlein,** S.M.'83, in early February. Teradyne continues to build a staff around Carol and sends her back to M.I.T. each year to find more program graduates. She spoke to several members of our current class, talking about her own job search at the end of her year here and her decision to go with Teradyne. She loves it there, feels she is really making a difference, and continues to feel she made the right choice. Her only mild complaint was there isn't enough time for socializing.—Jane Morse, Program Manager, M.I.T., Room E52-125, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

The automotive industry's long search for a practical continuously-variable transmission may be over, says **Theodore C. Kraver,** '60, president of Kumm Industries, Inc., Phoenix. After five years' development, Kumm's design passed development tests for the Department of Energy/NASA electric and hybrid vehicle program late in 1984, with efficiencies above 90 percent. Kraver says that the Kumm CVT "may become the transmission of choice for the automotive market."

Robert A. Summers, Sc.D.'54, writes, "On April 30, 1984, I assumed the position of chief, Verification Division, Bureau of Verification and Intelligence, U.S. Arms Control and Disarmament Agency, Washington, D.C." . . . **James W. Neighbours,** '41, reports, "I have retired for the third time and now enjoy life in Southampton, N.Y., when not traveling."

Luat T. Nguyen, S.M.'68, an aerospace technologist in the Low-Speed Aerodynamics Division at NASA's Langley Research Center, Hampton, Va., received a NASA Exceptional Engineering Achievement Medal last November. The citation read: "For his outstanding technical contributions which provide a dramatic enhancement of maneuverability, agility, and safety for highly-maneuverable military aircraft at high angles of attack."

Kenneth T.Y. Kung, a graduate student in the Department of Electrical Engineering and Computer Science, has been named the 1984 Russell and Sigurd Varian Fellow by the American Vacuum Society. The announcement was made last January at the Society's National Symposium held in Reno, Nev. Kung was selected for his excellence in vacuum science and technology, based on his doctoral work in plasma enhanced chemical vapor deposition, contributing to VLSI (very large scale integrated circuit) research.

XVIII MATHEMATICS

The M.I.T. Mathematics Department has successfully petitioned the faculty to award a new degree—the Bachelor of Science in Mathematics and Computer Science—effective in 1986. The idea is to fill a gap for students "who are serious about both mathematics and computer science," says Professor Arthur Mattuck, chairman of the department. He thinks the program will attract some students from the overcrowded Department of Electrical Engineering and Computer Science. Developed in cooperation with Course VI, the new curriculum includes mathematics subjects sufficient for a degree in Course XVIII and four subjects from Course VI—"fairly stringent," says Mattuck, only for "serious students."

TECHNOLOGY AND POLICY PROGRAM

Dan Saltzman, S.M.'80, has accepted a position recently with CH_2M Hill, Seattle, Wash. . . . **Steven Pinkerton,** S.M.'84, has co-founded a new alternative energy company—Under the Sun—in Quincy, Mass.

Ghassan Bejjani, S.M.'85, has accepted a position with Morgan Stanley, New York City. . . . **Adam Jaffe,** S.M.'78, will complete his Ph.D. in June from the Economics Department of Harvard University. He has accepted a position with the National Bureau of Economic Research, Cambridge. . . . **Miren Salsamendi,** S.M.'79, has a new job in the Planning Department of ARCO Chemical Corp., Newton Square, Penn.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA

Patrons Leave Their Stamp on Arts and Architecture

List Visual Arts Center Opens in AMT

The dedication of the Albert and Vera List Visual Arts Center on March 1 inspired a day of ceremonies and exhibition openings that drew hundreds of members of the institute community.

The relocated Hayden Gallery is at the heart of the List Visual Arts Center, which also includes two additional galleries, a preparation room, a film/video theatre and seminar room, offices, an atrium, and a sculpture garden. It is located on Ames Street (across from East Campus), in the new Arts and Media Technology Building (AMT) which is still under construction and scheduled to be dedicated in October.

The List Visual Arts Center triples the gallery space devoted to professional exhibitions at M.I.T. and ensures that its traditional concern for visual art will be related to media technology on a scale heretofore not possible, according to a joint statement for the occasion by President Paul E. Gray, '54, Jerome Wiesner, President Emeritus and chairman of the Council for the Arts, and David Saxon, '41, chairman of the Corporation.

The dedication focused on the role of the Lists in the arts at M.I.T. Mrs. List joined the Council for the Arts in 1972, at the suggestion of her cousin, Max Wasserman, '35. As a member of the acquisitions committee, she helped to shape the Institute's Permanent Collection. In 1977, the Lists endowed the Student Loan Program, to make art prints available to students living on campus.

It was also in 1977, as she recounts, that Mrs. List became excited at the prospect of a facility dedicated to the arts. She and her husband were the catalysts, offering to contribute $1.5 million to such a project. The List Foundation committed an additional $1.5 million.

Something of the power of contemporary art to motivate patrons like the Lists was conveyed by the dedication speaker, Marcia Tucker, whose address is printed almost *in toto* as follows:

"I first met Vera List in 1976, when I had organized an exhibition of the work of sculptor Richard Tuttle at the Whitney Museum. To say the show was controversial is an understatement, since Tuttle's work is often very small (about an inch wide), rapidly executed (perhaps a minute and a half), and made of inexpensive materials (wire, shadow, pencil). None of these characteristics is held in high esteem among the general public in America, which tends to value time, size, and materials over ideas. Vera's joyous response to the exhibition was that she didn't understand it and was therefore intrigued, perplexed, provoked, challenged, and intensely interested in the work. Similarly, Albert List's quiet, long-term, and far reaching commitment to the arts, like Vera's, has been one of continuous support for the organizations, institutions, and en-

MARCIA TUCKER is director/founder of The New Museum of Contemporary Art.

Left: Marcia Tucker delivers the dedication lecture for the Albert and Vera List Visual Arts Center. Below: Jerome Wiesner leads an audience tribute to Albert and Vera List (seated, center). Opposite: "Horse" by Deborah Butterfield moves visitors perhaps to exasperation, certainly to think, as Tucker described.

deavors which present the most interesting and often radical art of our time.

I'd like to talk about why contemporary art is important . . . why something which continuously addresses what we don't know, rather than what we do . . . should be essential to our lives.

Awkward, Overwhelming, Intrusive

I know that it may be difficult to see how contemporary art affects the world we live in, although it isn't difficult to see how our world affects the art we see. Art certainly seems increasingly powerless to effect political or social change.

And it's also difficult to see art as a pure endeavor, as one which exists in the realm of esthetics alone, one that creates for us a vision of perfection, unity, and harmony in the midst of an inharmonious world. This is because most of the work we see today doesn't look beautiful, by any conventional standards—its colors are discordant, its shapes awkward and primitivistic, its size overwhelming, its message distressing, its presence intrusive. The words "art" and "beauty" are no longer synonymous, and haven't been for almost two centuries.

Moreover, art no longer exists outside the marketplace, as it were. While the majority of artists, young and old, are still struggling, and while parents throughout the country still recoil in horror at the words, "Mom, Dad—I've decided to become an artist!", art has become big business . . . or at least, some of it has. Paintings by artists in their early twenties are selling for tens of thousands of dollars.

But for the most part, artists have little visibility and less glamour, and their lives are full of trying to balance jobs as carpenters, waitresses, or paste-up artists with making art late at night in the studio—or behind the washer-dryer. And, as the composer Morton Feldman pointed out, "For an art to succeed, its creator must fail." The best art, certainly, is one which learns from its failures, and not from its successes.

So: of what use is it? Well, contemporary art does in fact move us—to laughter, to anger, to contemplation, to tears, to exasperation—but more important, if you agree that the heart and mind are inextricably connected, it moves us to *think.* And to think, really think, is to learn, and ultimately to grow.

Wooed from Formalist Analysis

I once heard, many years ago, a brilliant lecture on the relationship between camouflage activity in insects and perception as it applied specifically to the visual arts. It turned me around completely, wooing me away from the ranks of formalist analysis, from the lure of the picture plane and the framing edge, forever. That lecture, which I attended by accident, with a friend, was given here at M.I.T., and convinced me beyond a doubt that the only question of interest was the way in which art related to the real world, to the world at large.

The new Albert and Vera List Visual Arts Center belongs at M.I.T. because art and science, art and technology, art and experimentation of every sort (or almost every sort!) belong together.

The wonderful thing that contemporary art can do for us, and for society, is to remind us of our essential freedom in all things. It's not just that artists don't have to conform to any dress code—*it's that the freedom to think and act at the very limits of one's intelligence is a essential to being an artist today as the ability to draw once was.* And that freedom carries over to us, the viewer, for whom the breadth and complexity, the audacity and intensity of the artist's imagination cajoles, seduces, threatens and demands of us a similar exercise of the intellect. It forces us to reach beyond what we know into that arena of possibility, into that forbidding and dangerous place where we have not been, and where, if we're fortunate, we also can enthusiastically welcome what we don't understand. —*Marcia Tucker* □

National Champion

Senior Patrice Parris ended an outstanding season March 8 by winning the 35-pound weight throw at the National Collegiate Athletic Association (NCAA) Division III Indoor Track and Field Championships, held at Bates College, Lewiston, Me. The 6'3", 215-pound native of Georgetown, Guyana, threw the weight 60'-7 1/4" to finish ahead of Scott Remillard of Union College in New York, who was next at 59' 3/4". Parris is only the fourth M.I.T. athlete to win a national title in NCAA Division III competition.

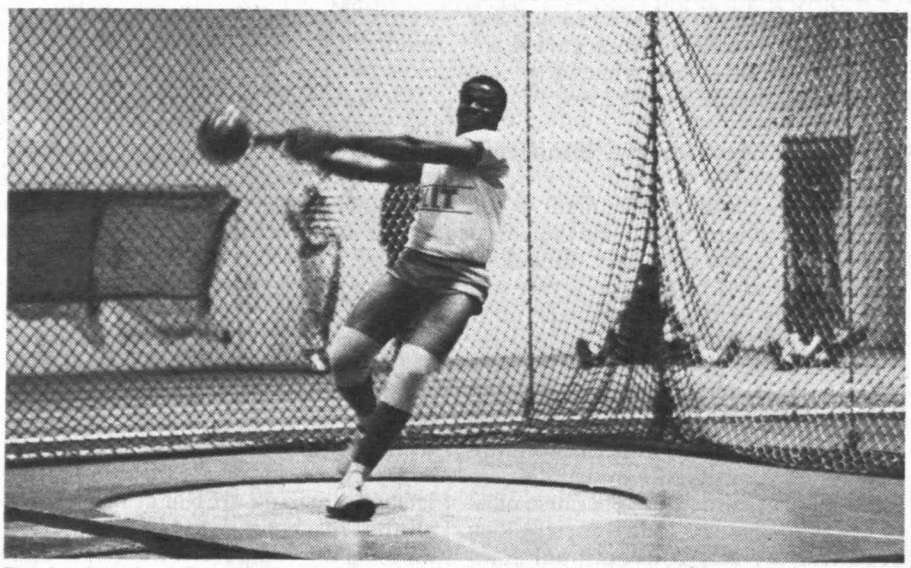
At the same meet, senior Greg Procopio of West Collingwood, N.J. was fourth with a personal best of 55' 3/4", and M.I.T. tied for ninth among 57 schools in the team scoring. For their efforts, both Parris and Procopio were named indoor track All-America's.

Parris, who is co-captain of the team, is three-time New England Division III champion in the weight throw and third highest all-scorer in indoor track at M.I.T. with 179 points. He broke the 29-year-old school record in the weight (held by John Morefield '56) with a toss of 61'6". The score won him fourth place at this year's prestigious IC4A Championships, which brings in the cream of the crop from all divisions playing in the Northeast. *Ken Cerino* □

Consorting with Supercomputers

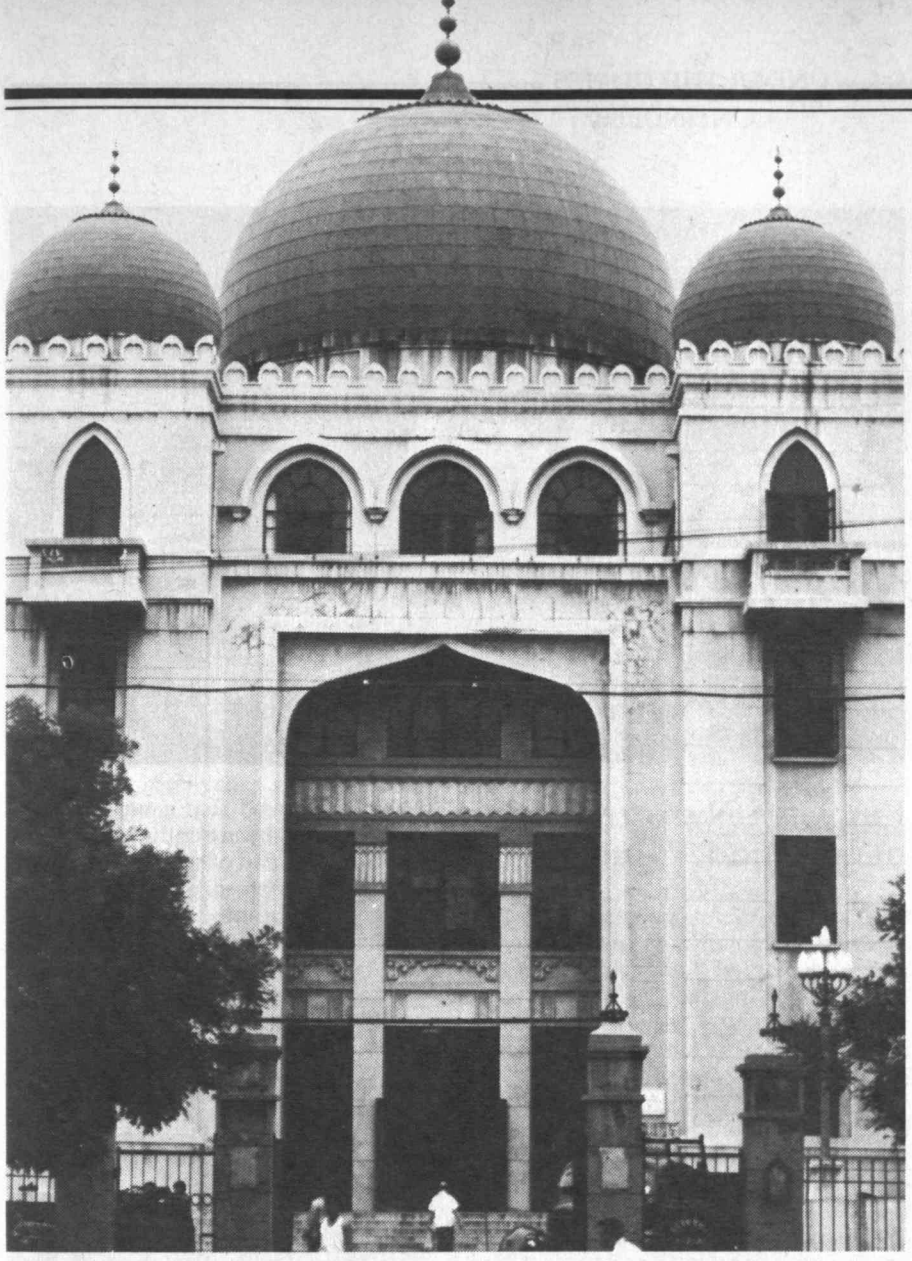
A consortium of research institutions that includes M.I.T. is one of four groups recently selected to operate supercomputer centers, under a National Science Foundation grant of about $200 million. The Consortium for Scientific Computing, which includes M.I.T. and eleven other institutions from the Northeast and Southwest, will locate its John von Neumann Center near Princeton, N.J. The Center's first supercomputer, a Control Data Cyber 205, and its successor, an ETA Systems ETA-10, will be connected to member institutions by networks. The supercomputers will be accessible to M.I.T. users through the campus computer network.

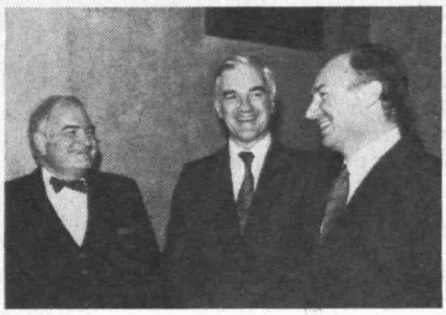
According to NSF officials, the overall program will fulfill two vital purposes: it will answer the academic community's



Patrice Parris

PHOTO: KEN CERINO





Above: Renewal of the Aga Khan Program for Islamic Architecture was announced by (l. to r.) President Gray, Harvard President Bok, and the Aga Khan. Left: This newly-constructed school is part of a "little renaissance" in the Islamic community in the People's Republic of China, which was documented by graduate students Cherie Wendelken and Zhu You-Xuan. Theirs was one of many summer projects supported through the Aga Khan Program.

overwhelming need for computer power to solve fundamental problems in such areas as meteorology, minerals exploration, and nuclear energy research; and it will ensure customers for U.S. manufacturers of supercomputers, enabling them to compete more effectively with their Japanese counterparts.

The four centers will concentrate on different aspects of supercomputer science. Broadly, groups based at the University of Illinois and Cornell University will develop new supercomputer technology, while the M.I.T.-connected consortium and another centered on the University of California, San Diego will focus on how to provide maximum scientific service with existing technology. According to Professor James D. Bruce, director of Information Systems at M.I.T., the von Neumann Center will emphasize high-speed communications and remote access as a key to the effective use of shared supercomputer resources. □

Islamic Architecture Program Granted $9M for 10 More Years, Seeks New Directions

For the past five years, M.I.T. and Harvard University have created an ambience in which East can meet West—through their joint Aga Khan Program for Islamic Architecture. In the process, they have plainly impressed the program's patron, the leader of about 15 million Ismaili Muslims. In March, the Aga Khan announced a new grant of approximately $9 million to extend the joint program over the next decade.

In part, the new funding will strengthen activities already under way in the program, set up with the original gift of $11.5 million. But the major purpose of the new grant is to launch fresh ventures. Up to now, the program has basically had an academic and research focus. In its second phase, it will also undertake the post-professional training of architects who want to design structures for Islamic countries and regions. The program provides "an important expansion of our capacity that would not have been possible otherwise," declared President Paul E. Gray '54, at a press conference annoucing the new funding, and enables M.I.T. to reach out to "a broader range of societies and cultures."

M.I.T. has a unique role in the new phase. In September, it will become the first institution in the Western world to offer a master of science degree in architectural studies with a specialization in Design for Islamic Cultures. The program is geared to students who want to acquire the skills for designing or teaching and researching architecture in Muslim nations. "We hope that graduates of both the professional and scholarly programs will find leadership roles in developing countries," said William L. Porter, professor of architecture and director of the program at M.I.T.

Another major aspect of the new work will be developing links between Cambridge and insitutions in the Islamic world, through cooperative teaching, research, and staff exchanges.

Even with millions of dollars in funding, the Islamic artchitecture program will never produce large numbers of graduates, the Aga Khan conceded. But small groups of people often have the greatest impact in their own communities, he pointed out, "and that is, after all, the work of the great universities of the world."—*Peter Gwynne* □

PHOTOS: CHERIE WENDELKEN, CALVIN CAMPBELL

Students who attended the Alternative Jobs Fair '85 (right) reported enjoying the enthusiasm they encountered among potential employers.

MacArthur Award to Toomre

How does it feel to pick up the telephone and learn that you're a MacArthur Foundation award winner to the tune of $230,000?

It's a "remarkable moment," says Professor Alar Toomre, '57, of the Department of Mathematics—like "winning a lottery without buying a ticket or a Pulitzer Prize without writing a book."

It happened to Toomre late last fall, when the MacArthur Foundation designated him to receive a MacArthur Prize Fellowship as a researcher of "exceptional talent, originality, self-direction, and promise for the future." He's the eighth member of the M.I.T. faculty to be tapped since the MacArthur program began in 1981.

Born in Estonia in 1937, Toomre came to the U.S. in 1949. He studied physics and aeronautical engineering at M.I.T., then went on to the University of Manchester, England, and finally joined the Mathematics Department at M.I.T. in 1960. He has won widespread attention for work on the dynamics of galaxies. □

Pugwash Nurtures Mix of Jobs and Values

In the 1980s, college campuses, the traditional incubators of controversy and ideological change, have been accused of evolving into "hotbeds of social rest," as students focus on personal achievement in economic and professional terms.

In response to this shift in the winds of youth culture, the Student Pugwash group at M.I.T. undertook an important experiment in February. (Pugwash is an international, student-run organization that explores the impact of technology on society.) Entitled the "M.I.T. Alternative Jobs Fair '85," it was the first M.I.T. event of its type designed to help students focus on careers that link professional interests in science and technology with broader social values. Organizations that usually have limited interaction with science and engineering students were invited to participate. They included small, non-defense, high-technology companies with unconventional missions, nonprofit organizations and public interest groups, state and federal governmental agencies with technological concerns, and consultants and other self-employed professionals. Representatives of 35 organizations talked to roughly 250 students in encounters ranging from active recruiting to informal sharing of experiences.

The data from this experiment, namely student reaction to the fair, were very positive. "A wonderfully worthwhile effort—if only to shake up the thinking of students here," wrote one. Another remarked that it was "nice to talk to people who are enthusiastic, who are seeking instead of sought. I feel happily received instead of grudgingly let through." Still, another wrote, "It let me see that are socially conscious/public interest types in technical fields. This is important in these days of corporate worship. I now feel more confident about finding an alternative job." Alumni also attended, including several engineers and a patent lawyer.

Response from alumni asked to participate in the fair on behalf of their employers was mixed—some were very enthusiastic, others thought the fair unnecessary.

Concurrent with the Jobs Fair itself was a series of four workshops that expanded upon some of the fair's themes. Titles included "Funding Alternative Technologies: The Venture Capitalist's View," "Individual and Social Responsibility in the Workplace," "What is Public Interest Science?" and "How to Find a Non-Defense Industry Job."

Student organizers would be quite satisfied if events like the Alternative Job Fair could be eliminated because a full range of public interest jobs had become obvious, easily accessible, and well-paid. But they don't believe that's the case now. This year, Student Pugwash has just begun to ask a difficult question and attempt a collective answer. Above all, it has learned a great deal from this experiment, which will be applied in years to come.—*Harry Atwater, '81* □

HARRY ATWATER, '81, is a graduate student in Electrical Engineering and Computer Science, and was coordinator of the M.I.T. Alternative Jobs Fair '85

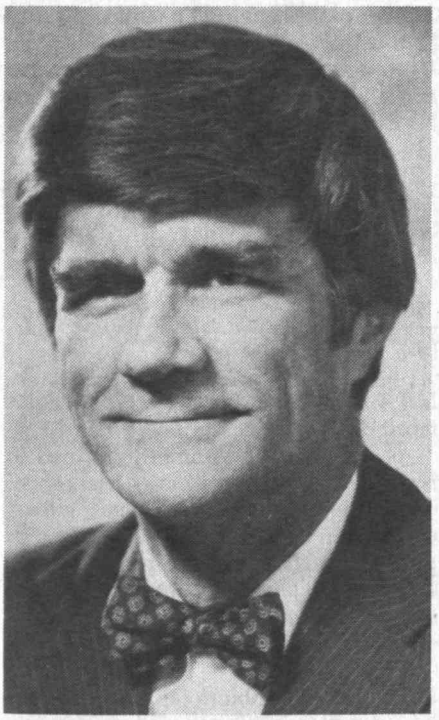
PHOTO: HARRY ATWATER

Highway Safety Pioneer Lived a Life "Deserving of Prominence"

A TRIBUTE BY RALPH NADER

William Haddon Jr.
1926-1985

Physician William Haddon, Jr., '49, a leader in highway accident research, died in Washington, D.C. on March 4 of the complications of kidney failure. Consumer advocate Ralph Nader believes that Dr. Haddon's career owed much to his M.I.T. education and that his death at 58 was a tremendous loss to the cause of highway safety. In many ways, Dr. Haddon's life exemplified the values propounded by Nader when he gave the keynote address at the Alternate Jobs Fair, organized in late winter by the M.I.T. Student Pugwash (see facing page).



William Haddon, Jr.

"Loss prevention" is not a conventional focus for engineers and physicians, but Dr. William Haddon performed so brilliantly in that field that students aspiring to technical and medical careers can benefit greatly from an awareness of his contributions.

After obtaining degrees from M.I.T., Harvard Medical School, and the Harvard School of Public Health, Haddon spent 10 years with the New York State Department of Public Health. He was concerned with highway traffic casualties, which at that time attracted few minds possessing staying analytic power and follow-through stamina, traits Haddon had in ample supply.

Motor vehicle crashes and trauma were failures in energy management, in Haddon's view. He separated the vehicular crash phenomenon into pre-crash, crash, and post-crash stages in order to clarify the intervention appropriate for each stage. Haddon demonstrated how the engineering intervention known as crashworthiness—exemplified by air bags—could manage the lethal transfers of energy in a crash to save life and limb. Through his studies on alcohol-related crashes, he was familiar with those data. But he believed that the engineering approach had a greater chance of reducing death and injury than any available method for controlling the complex behavioral sources of drinking and driving.

This emphasis on engineering remedies was rooted in Haddon's knowledge of empirical successes throughout history (which he cited frequently)—from the Greek physician Hippocrates to advances in factory and railroad safety for workers—and in his detailed knowledge of crash protection systems which were available but not in use.

In the 1960s, Haddon was part of the growing consumer challenge to the automobile industry though his writings, testimony, and television and radio interviews. From 1966-1969, he was the first administrator of the National Highway Traffic Safety Agency established by President Johnson. Under Haddon's direction, the agency issued motor vehicle safety standards, conducted research, and required the recall of defective vehicles and tires.

After leaving government, Haddon became the president of the Insurance Institute for Highway Safety in Washington, where he took the lead in transforming the insurance industry into a critic of unsafe and costly vehicular engineering. He also helped establish the Highway Loss Data Institute, which provided safety information on vehicles by make and model.

The words that come to mind when reflecting on Haddon's work are rigorous, dedicated, unyielding in purpose, humane, blunt, and a long-distance runner. He traversed the whole continuum—making major contributions to a conceptual foundation for trauma prevention, to public education, safety regulation and research, and to a new perception of the mission of the insurance industry. Haddon also raised the status of professional work in trauma prevention—introducing younger members of relevant professions such as statistics, engineering, and biology to the cause of saving lives through knowledge and its application.

Haddon's was a life to be celebrated, deserving of prominence, in the hope that many will follow in his footsteps if they only know of his trail. □

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

John B. Welch, '13; October 3, 1984; Indianapolis, Ind.
Atwood P. Dunham, '17; December 14, 1984; Dedham, Mass.
Raymond E. McDonald, '17; October 18, 1984; Natick, Mass.
Freeman H. Dyke, '20; March 8, 1984; Tequesta, Fla.
Fraser M. Moffat, '20; October 24, 1984; Montrose, Penn.
William D. Shepard, '20; January 1985; Winnetka, Ill.
James J. Wolfson, '20; November 14, 1984; Hallandale, Fla.
Chester A. Rimmer, '21; February 7, 1985; Norwell, Mass.
George T. Boli, '22; 1985; Venice, Fla.
John F. Hennessy, '22; February 9, 1985; Chestnut Hill, Mass.
W. Raymond Hewes, '22; December 24, 1984; Needham, Mass.
James D. Sarros, '22; December 27, 1984; Madison, N.J.
Mrs. Francis W. Spalding, '22; July 1984; Cincinnati, Ohio.
Arthur R. Belyea, '23; December 16, 1984; Old Saybrook, Conn.
Arthur Raymond Holden, '23; February 11, 1985; Sarasota, Fla.

PHOTO: INSURANCE INSTITUTE FOR HIGHWAY SAFETY

ALLAN J. GOTTLIEB

Fun with Trig

Since it has been over a year since I reviewed the criteria used to select solutions for publication, let me do so now.

As responses to problems arrive, they are simply put together in neat piles, with no regard to their date of arrival or postmark. When it is time for me to write the column in which solutions are to appear, I first weed out erroneous and illegible responses. For difficult problems, this may be enough; the most publishable solution becomes obvious. Usually, however, many responses still remain. I next try to select a solution that supplies an appropriate amount of detail and that includes a minimal number of characters that are hard to set in type. A particularly elegant solution is, of course, preferred. I favor contributions from correspondents whose solutions have not previously appeared, as well as solutions that are neatly written or typed, since the latter produce fewer typesetting errors.

Finally, let me credit David Griesedieck as the solver of **OCT 3**. Somehow his name disappeared when the column travelled from New York to Cambridge.

Problems

M/J 1. We begin with a two-part bridge problem from Doug Van Patter based on the following deal:

	♠ A 8 4 ♥ A K 10 ♦ A 7 6 5 4 ♣ K J	
♠ K ♥ Q J 9 4 3 2 ♦ Q 9 8 3 2 ♣ Q		♠ Q J 10 3 2 ♥ 8 6 5 ♦ J ♣ 10 7 5 4
	♠ 9 7 6 5 ♥ 7 ♦ K 10 ♣ A 9 8 6 3 2	

How does South make five clubs after an opening lead of the ♦Q, and what lead sets this contract?

M/J 2. As I look out my kitchen window and see our lake frozen solid, I am warmed by Phelps Meaker's N-sided flower garden described in the following problem, entitled "Fun with Trig":

A large bed of flowers and greenery is laid out in the form of a regular polygon of N sides. A walk composed of N trapezoidal concrete slabs surrounds the flower bed. A circumscribing circle passing through the outer corners of the walk and an inscribing circle tangent to the inner flats of the trapezoids have circumferences in the ratio of almost exactly 191:165. The total area within the outer periphery of the walk and the area of the walk itself are in the ratio of 4:1. Find N.

M/J 3. Lester Steffens wants you to explain a parlor trick he is fond of:

Given a number N between 500 and 1000, rapidly construct a series of numbers using eight of the nine digits from 1 through 9 once, the other digit twice, and a few zeros so that the series totals N. Example: if N = 642, a solution is

10
20
334
50
60
78
90

642

M/J 4. Winslow Hartford asks a multifaceted problem:

As we generate geometric figures to represent $y = x^n$, we have "elements" consisting of points, lines, faces, cubes, etc. as n increases. For the number of points in each figure, we have (for $n > 0$) $P = 2^n$. Derive the number of lines and faces in a five-dimensional hypercube.

M/J 5. Eric Schonblom tells us about his 8.01 doodles, with an apology for tardiness: "Having discovered this during

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, ASSOCIATE RESEARCH PROFESSOR AT THE COURANT INSTITUTE OF MATHEMATICAL SCIENCES, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y., 10012.

a physics lecture over 30 years ago, I'm a little slow in sharing it. It's a paper-and-pencil puzzle but is most easily stated in terms of scrabble tiles":

Take the letters in the first half of the alphabet in order. Place the A on the table. Place the B next to one of the four sides of the A. Place the C next to the one of the six sides at the AB (or BA) pair. Then add the D and so on. If you do this correctly, when you reach the letter M you will have created a crossword-puzzle matrix of complete common English words, no proper names, no foreign words, and no acronyms or abbreviations. Having solved the problem as posed, can you add one or more letters to the A-M set and still retain complete words?

Speed Department

SD 1. Jerry Grossman wants to know what is so interesting about
$f(x) = x^{1/\log x}$,
where log is the natural logarithm.

SD 2. David Evans designed a single elimination tennis tournament for 37 contestants to have the minimum number of byes. How many matches were played?

Solutions

JAN 1. South is on lead and is to take six tricks against best defense with hearts as trump:

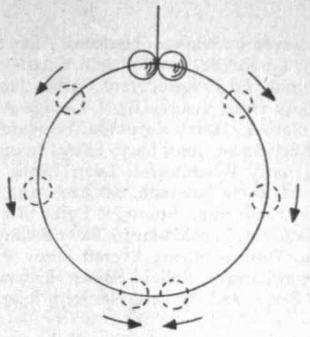
	♠ 9 8 3 2 ♥ 10 ♦ A Q ♣ —	
♠ J ♥ 8 ♦ J 10 9 8 ♣ 5		♠ 10 ♥ 6 ♦ K 6 ♣ K J 6
	♠ A K 7 ♥ — ♦ — ♣ A Q 4 3	

Ben Feinswog solved the problem by losing the ♠7 and discarding the ♠A and ♠K:
South plays the ♣A (removing West's exit), discarding the ♦Q from dummy, and then leads the ♠7 to West's ♠J. On the forced red-card return, South plays dummy's winning ♥10, and ♦A, discarding the ♠A and ♠K from hand, and claims the balance with dummy's last three spades.

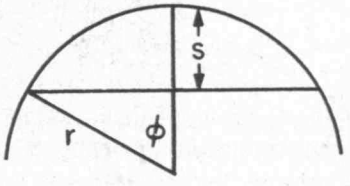
Also solved by Avi Ornstein, Doug Van Patter, Edgar Rose, Ellen Kranzer, Joe Hahn, John Lacy, Larry Wischhoefer, Matthew Fountain, Red Clevenger, Robert Lax, Roy Schweiker, Tim Maloney, Walter Cluett, Winslow Hartford, Jim Landau, John Rule, Richard Hess and Emmet J. Duffy.

JAN 2. A smooth, rigid, and circular hoop hangs from a rigid support by an ideal, extensionless string. Two small beads slide along the hoop (like beads of a necklace) with negligible drag and friction. The beads are slid to the top of the hoop and released. How massive must each bead by to spontaneously lift the hoop?

Matthew Fountain was pleased to submit a solution but even more pleased to report that his wife has responded perfectly to a recent cataract operation:
The two beads must total three times the mass of the hoop. As each bead slides outward, its circular motion causes a centrifugal force with an upward



component. At the same time its downward acceleration increases, decreasing the force that it exerts upon the hoop. The maximum lifting force occurs when the sum of these two effects is greatest. Until the hoop actually moves, a bead does no work. Therefore, its gain in kinetic energy equals its loss in potential energy. Thus, $(1/2)mv^2 = smg$, where s = vertical drop, m = mass, g = gravitational constant, and v = velocity.



When the bead has traversed an arc ϕ on the hoop of radius r, the vertical drop
$s = r(1 - \cos \phi)$.
The centrifugal force is mv^2/r, with an upward component
$(mv^2/r)\cos \phi = 2smg(\cos \phi)/r = 2mg(1-\cos \phi)\cos \phi$. Gravity produces a force mg acting downward through the bead. When the bead has traversed through the arc ϕ, the component of this force toward the center of the hoop is $mg(\cos\phi)$. In turn, the downward component of the radial component is $mg(\cos^2 \phi)$. The lifting force F exerted by a bead is
$F = 2mg(1 - \cos \phi)\cos \phi - mg(\cos^2 \phi) = 2mg(\cos \phi) - 3mg(\cos^2 \phi)$.
The maximum and minimum values of F occur when
$dF/d\phi = -2mg(\sin \phi) + 6mg(\cos \phi)(\sin \phi) = 0$.
Thus the minimum lift occurs when $\sin \phi = 0$ and the maximum lift occurs when $\cos \phi = 1/3$:
$F_{max} = (1/3)2mg - (1/3)^2\, 3mg = (1/3)mg$.
Each bead will lift up to one-third of its own weight.

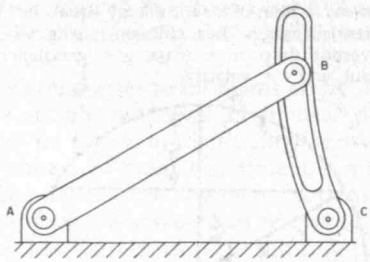
Also solved by David Smith, Gary Heiligman, Harry Garber, Harry Zaremba, John Lacy, John Prussing, Ken Haruta, Jim Landau, Richard Hess, Peter Kramer, and the proposer, Bruce Calder.

JAN 3. A man received a check calling for a certain amount of money in dollars and cents. When he went to cash the check, the teller made a mistake and paid him the amount which was written in cents in dollars, and vice-versa. Later, after spending $3.50, the man suddenly realized that he had twice the amount of money the checked called for. What was the amount on the check.

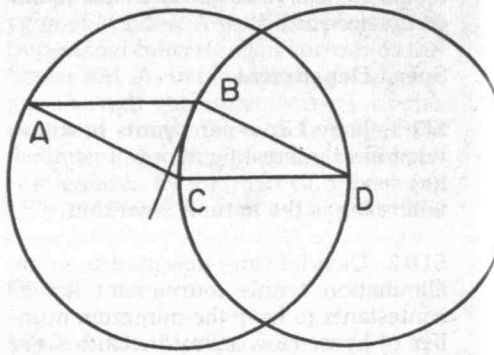
Red Clevenger provides a "down home" solution:
The problem reminds me of my eighth-grade teacher in rural Afton, Okla., who had several dollar-and-cents algebraic problems which she always wanted us to solve by using one variable. I preferred using two variables in simultaneous equations. She did drive home the lesson, however, of 100¢ = 1$.
Let
$ = the dollar amount of the check, and
c = the cents amount;
then the problem stated algebraically is:
$100¢ + \$ - 350 = 2(100\$ + c)$. (1)
The other equation results from the difference between the number of cents received ($) and twice the number of cents on the check (c) which must be − 50 since c is greater than $. Stated algebraically:
$\$ - 2c = -50$. (2)
Solving (1) and (2) results in $ = 14 and c = 32, and thus the check amount was $14.32.

Also solved by Winslow Hartford, Allan Benson, Anthony Lombardo, Avi Ornstein, Charles Sutton, David Smith, Edgar Rose, Frank Carbin, Fred Steigman, Gary Drlik, George Byrd, George Aronson, Harry Garber, Harry Zaremba, Howard Stern, James Michelman, John Lacy, John Prussing, Ken Haruta, Larry Wischhoefer, Leon Tabak, Marion Berger, Matthew Fountain, Michael Jung, Naomi Markovitz, Norman Spencer, Peter Silverberg, Phelps Meaker, Ronald Martin, Steve Feldman, Ted Numata, Thomas Stowe, Everett Leroy, Tim Maloney, Jim Landau, Ronald Raines, Richard Hess, George Parks, and the proposer John Rule.

JAN 4. A rigid arm pivots around the fixed point A. At the end of the arm is a follower (B) which runs in a curved track. The track pivots about the fixed point C. If AB = AC = r, find the shape of the track such that its slope at C is always vertical.



The problem as stated was rather easy. Surprisingly, several readers noticed that the diagram indicated a vertical slope at B, not C. This was indeed more interesting. Charles Sutton writes:
The problem as stated is trivial, since clearly a track in the shape of a semi-circle of radius r with center at A would remain stationary and its slope at C would always be vertical. I assume what was intended was that the slope of the track at B should always be vertical. This really had me going for a while. I set it up in rectangular coordinates, using anlaytic geometry and calculus, and ended up with an impossible differential equation. Then I tried polar coordinates, used a few trig identities and calculus, and got a real simple differential equation that integrated to give me a *circle*. Once you know what you're looking for, you need only elementary geometry. For the slope at B to remain vertical, the shape of the curved track is determined by the facts that AC = AB = r and the tangent to the track at B is perpendicular to the line at AC. Imagine that the track is held fixed; then point A will have to move on a circle of radius r. The accompanying diagram shows that the track is an arc of a circle of radius r with center at D. The tangent to the circle at B is perpendicular to both BD and AC, so AC must be parallel to BD. Also AC = BD = r, so ABCD is a parallelogram and AB = CD = r.



Also solved by David Smith, Gary Heiligman, George Byrd, Harry Garber, Harry Zaremba, Howard Stern, John Lacy, Jordan Wouk, Matthew Fountain, Phelps Meaker, Red Clevenger, Winslow Hartford, Richard Hess, Peter Kramer, and the proposer, Floyd Kosch.

Better Late Than Never

Y1984 Randall Whitman, William Thompson, Rick Lufkin, Marion Berger, Al Weiss, Matthew Fountain, Donald Trumpler, and Alan Katzenstein each improved on the published solution. When combined, their efforts yield the following list of revisions:

$2 = 1^9 \times 8/4$	$26 = (1 + 9/4) \times 8$
$3 = 4 - 1^{98}$	$31 = 49 - 18$
$4 = 1^{98} \times 4$	$37 = 1 + 9(8 - 4)$
$5 = 1^{98} + 4$	$41 = 49 - 8 \times 1$
$6 = (49 - 1)/8$	$42 = (49 - 8) + 1$
$7 = 91 - 84$	$49 = 49 \times 1^8$
$8 = 8 \times 1^{94}$	$68 = 81 - (4 + 9)$
$10 = 1^{48} + 9$	$70 = (9 - 1/4) \times 8$
$14 = 14 \times (9 - 8)$	$76 = 94 - 18$
$16 = (1 + 9 - 8)4$	$81 = 4 \times 18 + 9$
$18 = 9 \times 4 - 18$	$99 = 98 + 1^4$
$22 = (89 - 1)/4$	$100 = (1 + 9^{8/4}$

JUL 2. Howard Stern notes that this problem appears in Martin Gardner's *Mathematical Circus*.

OCT 3. John Stackpole notes that the very week his **F/M 1** issue of *Technology Review* arrived, the Maryland Lotto game had ten participants match all six numbers and 827 match five out of six, giving strength to Griesedieck's assertion that the selection of numbers by participants is not random. Jonathan Hardis, the proposer, remarks that never have any of the large lotteries had a positive expected return for the player and also expresses the oft-stated political belief that these games constitute a regressive tax since they played to a disproportionately large extent by the poor.

Proposers' Solutions to Speed Problems

SD 1. It is constant, i.e. independent of x.

SD 2. 36. One contestant is eliminated each match.

SCIENCE/SCOPE

The feasibility of turning sea water into electricity is being studied in fusion energy experiments at Kyoto University in Japan. The studies involve a Hughes Aircraft Company gyrotron, a microwave tube that uses a spiraling stream of electrons to produce extremely high power microwave frequencies. Fusion energy holds tremendous potential because its source of fuel (hydrogen) can be extracted from sea water. It could produce large amounts of power with little or no radioactive waste and no threat of meltdown or explosion. In fusion energy research, the gyrotron's high-power radio waves heat hydrogen particles (plasma) to temperatures of tens of millions of degrees. These particles fuse under pressure, causing a thermonuclear reaction that provides energy for driving steam turbines.

A third communications satellite is being built for Indonesia as a replacement for one rescued from an errant orbit last November by NASA's space shuttle. Palapa B-3, set for launch in 1986, is the third in a follow-on series of spacecraft designed and built by Hughes for Perumtel, Indonesia's government-owned telecommunications agency. The Palapa B model has more than twice the capacity of Palapa A, which in 1972 unified the world's largest archipelago electronically. It can carry 1,000 voice circuits or a color television transmission in each of its 24 transponders.

Single-seat military aircraft will be able to fly low-altitude attack missions at night with a system now undergoing evaluation by the U.S. Air Force. The Low Altitude Navigation and Targeting Infrared System for Night (LANTIRN) permits attacks at night and in low-visibility weather while relieving a pilot of many manual targeting functions. Elements include infrared sensors, an automatic multimode tracker, a laser designator/ranger, and a terrain-following navigation system. These components are mounted in two pods installed under the aircraft. Hughes, as subcontractor to Martin Marietta, has supplied five modified Imaging Infrared Maverick air-to-surface missiles along with launchers and a missile boresight correlator (the device which automatically hands off targets from the pod sensor to the missile). LANTIRN is designed for the F-16, F-15, and A-10 aircraft.

Swedish JAS-39 pilots will have better views from their cockpits, thanks to a wide-field-of-view head-up display (HUD) that incorporates diffraction optics technology. The display saves pilots from looking down into the cockpit to read instruments by superimposing data on a clear plate mounted at the pilot's eye level. Compared with conventional displays, the new HUD is clearer and eliminates bulky support structures. Its wide field of view can be used with infrared or low-light-level TV imagery so pilots can fly high-speed low-altitude missions at night. Hughes produces the HUD using a proprietary process involving holographic techniques and lasers. Sweden is the first country to award a production contract for a HUD that uses diffraction optics.

Career growth opportunities exist at Hughes Support Systems for a variety of engineers qualified by degree or extensive work experience. They include systems engineers, radar engineers, and software and hardware design engineers for major simulation and test equipment programs. Also, field engineering posts throughout the U.S. offer travel, autonomy, and responsibility for the life cycle of Hughes electronics systems. Please send your resume to Lowell Anderson, Professional Employment, Dept. S2, Hughes Aircraft Company, P.O. Box 9399, Long Beach, CA 90801-0463. Equal opportunity employer. U.S. citizenship required.

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HUGHES
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Today's information technologies, with their potential for personal surveillance, require a new definition of privacy and a new regard for its sanctity.

The New Surveillance

BY GARY T. MARX

Most of us see computerized dossiers, x-rayed luggage at airports, credit checks, video cameras in banks and stores, and electronic markers on consumer goods as the normal order of things. We think of these technologies as essential to life as we know it, not as threats that enhance surveillance and social control. However, many of these familiar systems have the potential to do just that. Indeed, most of them are so subtle, diffuse, and voluntary that we are unaware of the extent to which surveillance has become embedded into everyday life.

Clearly these new forms of surveillance can be immensely beneficial. For example, the life of an elderly heart-attack victim who lived alone was saved when her failure to open her refrigerator sent an alarm through her telephone to a central monitor. A corrupt judge was caught when he took a bribe from an undercover police agent who tape-recorded the encounter. Serious crimes have been solved because of tips received on citizen hotlines. Advanced emergency systems that give a caller's location and phone number the instant an operator answers have saved lives. Satellite photography has monitored industry's compliance with emission standards. Credit cards have revolutionized travel and retail merchandising. Computer-matching programs may save tax dollars, and citizens may feel safer because of video surveillance in banks and stores.

Yet as large databanks and their management have become central to the workings of the modern industrial state, people have surrendered traditional notions of privacy for the sake of efficiency,

ILLUSTRATIONS: MICHAEL YOUNG

and the information-gathering powers of the state and private organizations have extended deep into the social fabric. In focusing on the power of these surveillance techniques, I do not suggest that we are hapless victims of technological determinism who can do little more than bemoan our loss of liberty. The fact that technology can be misused does not necessarily mean that it will be. Government legislation, good program design, and intelligent management have reduced the potential for errors and abuse. The United States has more restrictions on the use of surveillance technologies than most countries. Furthermore, some potential for surveillance has been neutralized by countersurveillance devices—such as the detectors that warn drivers of police radar units. However, there is often a significant time lag between the appearance of a new technology and its regulation, and regulation when it does come is often weaker than desirable. For example, many states still do not regulate the use of lie-detector tests.

I do not argue that more harm than good now comes from these new technologies. My point is simply that in our eagerness to innovate and our infatuation with the efficiency and gimmickry of technical progress in day-to-day transactions, the potentials for negative results from these new developments simply have not received enough attention. More should be done to safeguard privacy now, and still more as new technologies are perfected and more widely applied.

A New Era of Transactional Analyses

While adding immensely to the services rendered to consumers and companies, computer databanks have greatly increased the amount of personal information that is recorded and analyzed. The computers of the five largest credit-screening companies contain records on more than 150 million individuals, and most credit-card purchases are now approved electronically. The health records of nine of ten working Americans are computerized through their insurance policies. Even pharmacies have begun to keep computerized records of patients' use of prescription drugs. As electronic funds transfer has become central to banking, individual financial transactions have become part of long-lived computer records. And the size and reach of police databases, such as the FBI's National Criminal Justice Information Center, continue to grow.

Many similar records, including bank statements, health-care histories, and credit ratings, existed before the advent of computers. But electronic data processing allows these vast databases to be cross-checked. Bits of scattered information that in the past represented no threat to an individual's privacy and anonymity now can be correlated, such as the timing of phone calls, travel, and bank deposits. A thriving new computer-based data-scavenging industry now sells—chiefly for marketing but for other uses as well—information gleaned from sources such as drivers' licences, vehicle-registration and voter lists, birth, marriage, and death certificates, land deeds, telephone and organizational directories, and census records.

State and federal governments have established more than 500 programs to compare information from two or more sources, and private interests match records even more extensively. Consider the following examples:

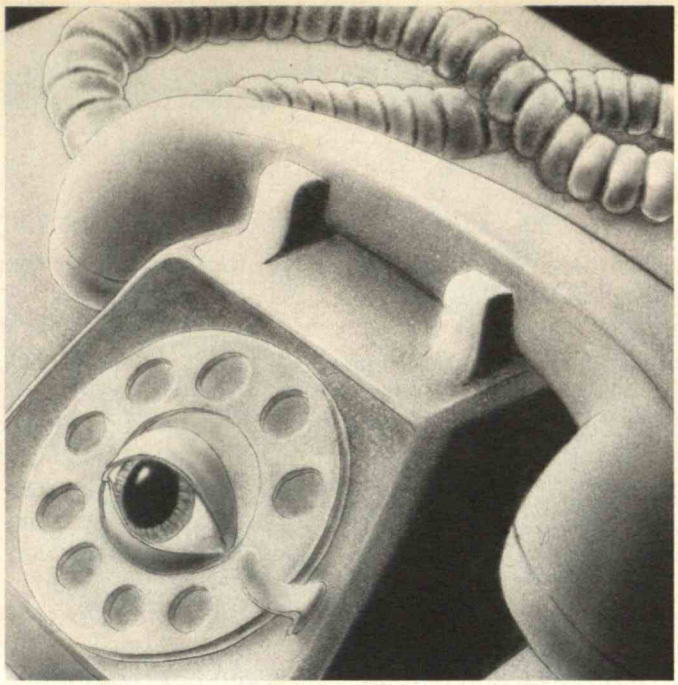
☐ A resident of a Massachussets nursing home lost her eligibility for government medical assistance because a computer determined that she had more than the minimum amount permitted in her savings account. What the computer did not know was that the money was held in trust to be used for her burial expenses. Such burial contracts are exempt from asset calculations. Another woman was automatically eliminated from welfare roles because a loan for her son's college education had been temporarily deposited in her bank account.

☐ A welfare recipient in Washington, D.C., obtained employment and repeatedly notified the welfare department of her new status. However, she continued to receive welfare checks in the mail, and she eventually cashed them to pay off doctor bills incurred from a serious illness. Finally, a computer match linking employment and welfare records resulted in her indictment on a felony charge. Her case was dismissed, but before her trial, a newspaper published her name (along with those of 15 others) in an article describing the "successful" results of computer matching.

☐ Residents of New York City cannot purchase a marriage license or register a deed for a new home if they have outstanding parking tickets. Such computer matching of disparate data is a pointed ex-

ample of its inherent threats to civil liberties.

Profiling, in which disparate clues are used to assess whether a person or event fits a model of known or suspected violators, is also increasingly common. For example, the Educational Testing Service used computer profiling in an effort to discover cheating on Scholastic Aptitude Tests in 1982. The ETS sent some 2,000 form letters alleging "copying" to students who had taken the tests, noting that a statistical review had "found close agreement of your answers with those on another answer sheet from the same test center. Such agreement is unusual and suggests that copying occurred." Students were told that in two weeks their scores would be canceled and colleges notified unless they provided "additional information" to prove they had not cheated.



Automatic telephone switching technology now records when, where, and to whom calls are made.

Tracking People's Whereabouts

Modern surveillance technologies now allow organizations to monitor people's movements to a degree previously imagined only in fiction. Aircraft that can spot a car or person 30,000 feet below have been used to monitor drug traffickers. Satellites may soon be used for this purpose as well. The CIA has apparently used satellite photographs to monitor antiwar demonstrations and civil disorders. Computer-enhanced satellite photography can identify vehicles moving in the dark and penetrate most camouflage materials.

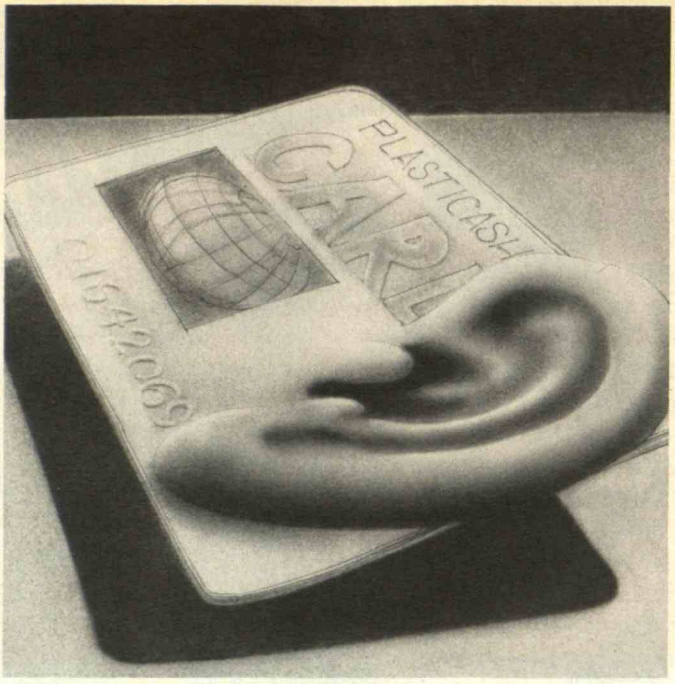
One-way video and film surveillance has expanded rapidly, as anyone who ventures into a shopping mall or uses an electronic bank teller should realize. Many stores use closed-circuit television to monitor the activities of both customers and employees. The cameras often have 360-degree movement and may be concealed inside ceiling globes with amber or mirrored surfaces.

Other devices now in use include sensitive miniature but powerful radio transmitters; tape recorders the size of a match box; video cameras the size of a deck of cards; instruments for detecting motion, air currents, vibrations, odors, and pressure changes; and voice-stress analyzers. A light amplifier developed for use in the Vietnam War requires only starlight, moonlight, or a street lamp several hundred yards away to provide enough illumination for a variety of film and video cameras and binoculars. Attached to a telescopic device, the amplifier increases the latter's range to over a mile.

The National Security Agency can simultaneously monitor 54,000 telephone transmissions to and from the United States. The agency operates beyond the usual judicial and legislative controls, and can apparently disseminate its information to other government agencies at will.

The Crime Control Act of 1968 makes it a felony for a third party—except for government agents under strictly defined conditions and with a warrant—to place electronic listening devices on telephones or in rooms. Yet this law does not apply to information transmitted in digital form. Thanks to technological changes since this law was enacted, an increasing proportion of telephone calls, including more than half of all long-distance hookups, is now transmitted in digital form. These messages, as well as all cellular mobile communications, conversations on cordless telephones, and communications among computers appear to be exempt from the wiretap law. In addition, automatic telephone switching technology now records when, where, and to whom calls are made.

Devices that can transmit information on the lo-



To venture into a shopping mall, bank, or subway is to perform before an unknown audience.

cation and physiological condition of the wearer—such as pulse-rate monitors developed to improve health care—are now being used to permit continuous remote surveillance of criminals. In at least four jurisdictions in Florida and New Mexico, some offenders must wear an anklet containing an electronic transmitter. If the wearer goes outside a specified territory, the signal is interrupted, alerting the computer. This "electronic leash" is being used in other contexts as well, such as to allow police supervisors to determine the exact location of patrol cars at all times.

Indeed, the Hong Kong government is testing an electronic system for monitoring where, when, and how fast a car is driven. The information will be used to levy a road-use tax to help reduce Hong Kong's high concentration of cars. Low-frequency signals from wire loops set into streets trigger a car's small radio receiver, which then transmits an identification number to a central facility. A similar system could also be used to enforce speed limits and monitor individuals' movements.

Much has been written of the electronic office, where data-processing machines do routine tasks and electronic mail substitutes for letters and telephones. We forget, however, that these systems that make possible so much efficiency also allow monitoring of employees' productivity and behavior, including workers' time away from their stations and access to restricted areas. Surveillance of factory workers has likewise expanded with computerized electronic devices that measure work pace, detect mistakes, and deter thefts by detecting the location of tagged material.

The last decade has seen the increased use of supposedly scientific "inference" or "personal truth" technology. These systems, based on body clues, include polygraphs and analyzers of voice stress, blood, and urine. Some proponents even claim that brain waves can provide clues to certain internal states, such as a person's degree of concentration or surprise.

Rising public concern about drunk driving has led to broad police use of roadblocks to screen large segments of the population. And determining the amount of alcohol in a person's system has now become easy: an officer need only hold a microphonelike device in front of a suspect.

New technology is also providing decentralized and inexpensive ways for each of us to help keep our neighbors safe and honest. For example, states have established many hotlines for anonymous reporting. These include a turn-in-a-poacher program in Connecticut and a program in Washington State that encourages motorists to report—sometimes on their mobile telephones—other motorists who improperly drive in expressway lanes reserved for car pools. Many federal agencies also maintain hotlines on which citizens can report abuses. For example, all 19 inspector general offices have set up telephone lines for receiving people's allegations of fraud, waste, mismanagement, and other abuses.

Many companies urge employees to report dishonesty among colleagues, and some support WeTiP, a nonprofit organization that operates a nationwide 24-hour toll-free hotline for reporting any kind of suspicious activity. TIP (Turn In a Pusher) uses anonymous reporting to help combat illicit drug use in hundreds of communities. A television program called "Crime Stoppers USA," seen in over 450 cities, is the video equivalent of the old-style reward posters. The program reenacts "the crime of the week" to encourage witnesses of unsolved cases to come forward.

Distinctive Attributes of the New Surveillance

All these efforts represent new opportunities for some citizens to learn about the activities—illicit or otherwise—of fellow citizens and hence infringe on their privacy. Although these surveillance methods differ, most share seven characteristics that distinguish them from traditional forms of social control.

☐ *The new technologies conquer distance, darkness, and physical barriers.* Surveillance was historically difficult simply because of the physical impossibility of seeing to the farthest regions of political jurisdiction, through closed doors, and into an individual's intellectual, emotional, and physical states. However, technical impossibility and, to some extent, inefficiency are losing their roles as the unplanned protectors of liberty. Sound and video can be transmitted over vast distances, infrared and light-amplifying technologies pierce the dark, intrusive instruments can "see" through doors, suitcases, and fog. Truth-seeking technologies claim to penetrate surface reality to uncover subterranean truths of the body and mind.

☐ *The new technologies transcend time, yielding records that can easily be stored, retrieved, combined, analyzed, and communicated.* Stored electronically, information can be available for instant analysis many years after it was accumulated and used in totally different contexts. Data can also easily migrate to places far removed from the original location.

☐ *The new technologies are capital-intensive rather than labor-intensive.* Technical developments making information much less expensive to gather have dramatically altered the economics of surveillance. A few people can monitor a great many people and places. Economy is further enhanced because people have become voluntary participants in and consumers of much of this technology.

☐ *The new techniques broaden the base of surveillance.* Instead of targeting a specific suspect, today's instruments survey everyone and operate continuously and tirelessly. The new surveillance is decentralized in that data are available to widely dispersed users for many different purposes. The camera, the tape recorder, the magnetic identity card, the metal detector, the ubiquitous computerized form make all who come within their province reasonable targets for surveillance, pushing us toward a society where people feel constantly under suspicion. As the French social theorist Michel Foucault observed, the never-ending threat of "judgments, examinations, and observation" has superseded physical coercion as our society's major form of control.

☐ *The new surveillance technologies are chiefly concerned with preventing violations and reducing risk and uncertainty.* These are positive benefits, and proponents are likely to extensively promote the use of the techniques to deter violations, to catch violators in the act, and to obtain strong evidence of criminals' identity. These social benefits tend to make us indifferent to the negative effects of the technologies on individual freedom.

☐ *Those watched by the new surveillance techniques often become active partners in their own monitoring.* These systems may be self-activated and automatic, triggered when people move, talk on the telephone, turn on a television set, check a book out from the library, or enter or leave controlled areas.

☐ *The new surveillance techniques have low visibility or are invisible, and they are increasingly depersonalized.* Ascertaining when or whether we are being watched, and who is doing the watching, becomes ever more difficult. Because much of the surveillance is covert, accountability is lessened and exploitation invited.

Rethinking the Nature of Privacy

Citizens' ability to evade all this surveillance is diminishing. To participate in the consumer society and the welfare state, we must provide personal information. To venture into a shopping mall, bank, or subway, sometimes even into a bathroom, is to perform before an unknown audience. To apply for a job, we may have to face lie-detector tests concerning intimate details of our lives.

To avoid such intrusions, people may decline needed services such as mental-health care, and avoid controversial actions such as filing grievances against landlords or governments. We may shun risks and experiments as the new technology exerts subtle pressure for conformity at the expense of diversity, innovation, and vitality.

In a society where everyone feels as if he or she is a target for investigation, trust—the most sacred and important element of the social bond—is damaged. Indeed, today's surveillance technologies may be cre-

ating a climate of suspicion from which there is no escape. Proving innocence in such a society may become vastly more difficult than inferring guilt.

Furthermore, the new surveillance is lessening the power of the individual relative to large organizations and government. Individuals and even public-interest groups clearly do not have the monitoring capabilities of credit-card companies and market-research firms, landlords' associations and real estate syndicates, police intelligence units, the National Security Agency, and banks and large corporations. Organizational memories extend over time and across space, making surveillance broader, deeper, and even routine.

Today's surveillance technologies could easily be used against those with the "wrong" political beliefs.

Even if one denies the potential danger of our present situation, the possibility of future disasters remains. Social conditions may change: a more repressive government or a less tolerant public may gain sway in the United States—perhaps because of a severe economic downturn, immigration pressures, or a major foreign-policy or military defeat. Under such conditions, today's surveillance systems—and tomorrow's more powerful ones—could easily be used against those with the "wrong" political beliefs, members of racial, ethnic, or religious minorities, and even those whose lifestyles offend the majority. Attempts to prevent disorder could lead to vastly expanded use of surveillance systems to identify and persecute "suspects," with patriotic necessity the rationale for the gradual erosion of liberties.

We need to recognize that the potential for harm from certain surveillance systems may be so great that the risks outweigh their benefits. At least two widely discussed examples come to mind: the idea of creating linkages between all federal and state databanks, and the plan for a mandatory national identification system.

We could not turn the clock back even if we wanted to; the new technologies that both serve us well and threaten us all are here to stay. Our response must be to rethink the nature of privacy and create new ways to protect it. Some protection measures, ironically, will rely on the same technologies that we find threatening, such as encrypted communications and debugging devices. Legislation to protect privacy is also crucial. The 1984 Privacy Act—which requires that individuals be notified that personal records are being kept, affords them the right to see and correct such records, and prohibits information provided for one purpose from being used in an unrelated context—applies only to federal records. These restrictions must be better enforced and extended to state, local, and private-sector records. Less than 1 state in 5 now has standards for collecting and disseminating personal information. The public must also be informed about the power of surveillance devices and told when they are in use. "Truth-detection" systems that rely primarily on trickery and intimidation to gain results should be strictly regulated. Greater attention must be paid to the accuracy and currency of the data collected by all these techniques and means of redress provided to persons whose rights are violated.

The first task of a society that would protect liberty and privacy is to prevent physical coercion on the part of the state and private parties. The second task is to limit the information on individuals that can be collected and the ways that it can be manipulated. This is clearly the more difficult task, as such control is often invisible, diffuse, and shrouded in benign justifications. As Justice Louis Brandeis warned a half-century ago, "Experience should teach us to be most on our guard when the government's purposes are beneficent. Men born to freedom are naturally alert to repel invasion of their liberty by evil-minded rulers. The greatest dangers to liberty lurk in insidious encroachment by men of zeal, well-meaning but without understanding."

GARY T. MARX is professor of sociology in the M.I.T. Department of Urban Studies and Planning. This article is drawn from an unpublished paper, "The Iron Fist in the Velvet Glove: Totalitarian Potentials within Democratic Structures," also the source of an article in Dissent *(Winter 1985).*

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Genetic testing in the workplace promises significant health benefits. But some of its potential uses raise important ethical questions.

Genetic Testing at Work: How Should It Be Used?

BY THOMAS H. MURRAY

WHO we are—genetically speaking—is becoming increasingly important in the workplace. New research shows that our genes, the raw material of heredity, can influence our susceptibility to illness resulting from exposure to chemicals and other substances in the work and home environment. Slight differences in genetic makeup may, for instance, explain why some people succumb to cancer after years of cigarette smoking while others similarly exposed do not. At the same time, researchers are discovering that certain materials can scramble the genes of groups of workers regardless of their individual genetic makeups.

U.S. manufacturers have become intrigued with the idea of using this new knowledge to lessen the toll of occupational disease. The potential benefits are enormous. More than 55,000 chemicals are now used in commerce, and another 800 are added each year. At least 9 million American workers are exposed to chemicals in manufacturing and many other industries. The U.S. Bureau of Labor Statistics estimated that there were 126,000 cases of acute work-related illness in the private-sector workforce alone in 1981, leading to more than 850,000 lost work days. This figure undoubtedly understates the incidence of occupational disease, since it excludes government workers, chronic ailments such as asbestosis, and diseases such as cancer that have a long latency period between exposure and onset.

On-the-job exposures also cost industry substantial sums. Companies lose money from missed work days, and they must also bear the price of training replacement workers and paying higher premiums for health, life, and workers'-compensation insurance. And then there are the legal costs. The total damages sought by former asbestos workers alone add up to a staggering $40 billion. Small wonder that companies are eager to apply newfound knowledge about genetics to reduce the incidence of occupational illness.

Most companies are exploring two different technologies for genetic testing. The promise of *genetic screening* lies in being able to identify people who are susceptible to certain illnesses. The goal of *genetic monitoring* is to understand the significance of genetic mutations that occur in groups of people as the result of exposure to chemicals, ionizing radiation, and other environmental agents.

Genetic screening and genetic monitoring are strikingly different in their proposed uses, and they raise very different moral problems. Since genetic screening enables us to differentiate among and possibly discriminate against individuals, its potential for abuse is far greater. The results of genetic screening could conceivably be used to justify denial of employment, job transfers, or even dismissal. In contrast, genetic monitoring is seen as a way of identifying substances, rather than workers, that should

ILLUSTRATION: JON MCINTOSH

Early sickle-cell programs showed that the impact of genetic screening is not always benign.

be removed from workplaces. Thus, the ethical problems associated with genetic monitoring are less troublesome than those involving genetic screening.

Both strategies have become highly controversial. Few companies are willing to admit that they are pursuing genetic screening, even on a research basis. Corporate critics have charged that such screening is being hidden from public scrutiny, and Congress is debating the issue with particular intensity.

What is so controversial about using a potentially beneficial set of medical technologies in the workplace? The answer comes in two parts.

First, for the better part of this century, genetics has often occupied an unfortunate place in the American political imagination. The concept of inherited genetic differences among individuals and races has been used all too often to justify social and economic inequalities. Such a rationale appeared in arguments about the deleterious effect of southern European immigrants on the future population in the United States. It erupted again in the infamous 1927 U.S. Supreme Court decision of *Buck v. Bell*, which upheld involuntary sterilization of the allegedly feebleminded. And it reemerged in the debate over heredity, race, and intelligence in the late 1960s. This kind of rationale leads us to search for solutions that emphasize individual differences, rather than to change the social circumstances that make biological differences into social liabilities.

Second, there are enormous economic and political issues at stake in the use of genetics at work. Should companies be permitted to select employees according to their inherited probability of contracting occupational illness? Or should we require that workplaces be healthful for all workers—including those predisposed to occupational illness? The cost of adapting workplaces for the most susceptible employees could be substantial.

Also at stake is the issue of who controls employment and placement decisions. Should individual workers decide how to respond to the results of genetic testing themselves, or should employers control who is transferred or asked to leave?

Genetic testing in the workplace is in its infancy. But given the enormous potential of these techniques, it may be only a matter of time before many companies embark on full-scale testing programs. We should begin now to examine the ramifications openly. A national consensus on this issue would come none too soon.

The most widely known genetic screening program in the U.S. is the test for newborns with phenylketonuria (PKU). A few drops of blood from a heel prick are enough to identify most babies who suffer from this enzymatic deficiency, which can cause severe brain damage. Once identified, PKU babies can be successfully treated with a special diet.

Illness and Its Genetic Component

The controversy over genetic screening in the workplace would never have arisen had it not been for the prodigious scientific leaps made in the last 30 years. Since the 1950s, we've known that the long-chained molecule called deoxyribonucleic acid—DNA for short—contains the basic information of human heredity. Each link in the chain holds one of four chemical compounds known as a base. A sequence of three bases specifies a letter in the genetic alphabet which, when "read," codes for a particular amino acid. Chains of amino acids called polypeptides carry on the work of life in the form of hormones, enzymes, and cellular building blocks.

In humans, a chain of DNA composed of a few thousand bases makes up a single gene—the instructions to make one polypeptide. A difference in one DNA base among thousands may be enough to produce a variant polypeptide, called a polymorphism. Researchers now know that specific polymorphisms may make us more or less likely to become ill. In humans, the genes themselves are strung together in 23 structures called chromosomes. Normal human cells contain two full sets of 23 chromosomes each, or 46 in all—one set inherited from each parent.

Scientists have known for some time that the tendency to develop a particular disease can be inherited. Some illnesses—such as Huntington's disease,

the tragic, progressive brain disorder that killed folk-singer Woody Guthrie, and phenylketonuria (PKU), which can cause severe mental retardation in young children—are traceable to a single gene. In other cases, a more complex relationship between genes and disease exists. Lung cancer and smoking is an excellent example. The relationship between the two is well known, but not all smokers—not even all heavy smokers—develop lung cancer. Some individuals appear to detoxify the carcinogenic components of tobacco smoke, while others transform the compounds in smoke into their cancer-inducing metabolites more readily.

More than one gene may be involved in these processes, but it is the *interaction* between genetic makeup and environment that causes disease. Being genetically predisposed means little until people suck smoke into their lungs. People with no genetic predisposition might be able to smoke with little or no risk of cancer. The idea that genetic susceptibility and environment interact to cause some diseases suggests that if we could identify people who are predisposed, we could reduce their risk of disease by keeping them away from environmental agents hazardous to them.

Tests for detecting many genetic polymorphisms are now available. A few are cheap and accurate enough to be used to screen large numbers of people. The PKU screening program for newborns is most familiar in this country. A few drops of blood from a heel prick are enough to identify almost all babies who suffer from the enzymatic deficiency that allows toxic levels of a common amino acid—phenylalanine—to build up in the blood. This abnormal buildup causes brain damage and behavioral disorders. Once identified, PKU babies can be placed on a special diet that carefully limits their intake of the usually benign phenylalanine. When maintained through adolescence, this diet appears to allow PKU victims to develop normally.

Not all genetic screening programs have been this successful. In the early 1970s, hospitals and clinics began to screen for the sickle-cell trait among blacks. Sickle-cell anemia is a crippling and often fatal condition that results from inheriting sickle-cell genes from both parents. However, some of the screening programs did not provide good counseling about the difference between having the sickle-cell trait—one sickle-cell gene and one normal gene with no symptoms—and having the actual disease. Some people with the trait believed that they had the disease, and carriers of the trait were sometimes shunned as marriage partners. These early programs showed that the impact of genetic screening is not always benign. Much depends on how the information is used.

In 1980, a series of articles in the *New York Times* described a program at a DuPont plant to screen black employees for sickle-cell trait. According to the *Times* reporter, ambiguous language in a paper by a DuPont scientist seemed to suggest that DuPont was using the results of the test to weed out black employees who might be especially susceptible to chemicals used at the plant. DuPont officials denied that the tests were being used for selection or placement. They said they had offered the free tests at the request of an organization of black DuPont employees for workers who wanted to know if they were carriers of the sickle-cell trait. The inferences the *Times* reporter made were reasonable, but so were DuPont's explanations. Genetic screening in the workplace was suddenly a hot political issue.

A key unanswered question was whether any other companies were using genetic screening and, if so, whether the results affected the job prospects of applicants or employees. The rash of publicity surrounding DuPont's program made other companies understandably reluctant to discuss their own screening activities. Congressional curiosity was piqued, and the House Committee on Science and Technology ordered the Office of Technology Assessment (OTA) to study genetic testing.

The OTA sent questionnaires to the 500 largest U.S. industrial companies, the 50 largest private utilities, and 11 unions. Only 5 of the 366 respondents said they were now using tests to screen for genetic polymorphisms such as sickle-cell trait or certain enzyme deficiencies. Another 12 said they had done so in the past 12 years, and 54 left open the possibility of using them within the next 5 years. Even more important, 18 companies reported taking one or more actions as a result of genetic tests. Of these firms, 8 claimed to have warned employees about potential problems, 5 reported transferring employees, 3 distributed personal protection devices, 2 suggested that the workers seek other jobs; 2 installed engineering controls to reduce workers' exposure to chemicals, 1 began research, and 1 discontinued or changed the product involved in the exposure. Because responses were anonymous, it was impossible to tell which companies were doing what.

The Moral Debate

Genetic screening could be used in the workplace for a number of possible purposes. And since purpose is the key factor in judging the moral acceptability of screening, it is worthwhile to examine these potential uses.

Research is one such use, and it is both appropriate and advisable for scientists to examine the links among genetic predisposition, workplace exposure, and disease. However, to a remarkable degree, research on occupational disease within corporations has escaped the scrutiny given to other research on human subjects in universities, hospitals, and national laboratories. Federal regulations do not require prior review of research conducted on employees unless the projects are federally funded. A few states regulate experimentation on human subjects, but most do not even require that subjects be informed that they are participating in research. Hence, it is not clear what employees are being told, or even if they can refuse to be research subjects.

More attention should be paid to the ethics of conducting research on human subjects in industry. Companies should at least be required to inform employees that they are enrolled in a research program. Better still, research should not be conducted unless it conforms to the ethical standards governing federally funded research.

Genetic screening can also be used for diagnostic purposes as opposed to research. When a physician is confronted with an ill worker, that physician is morally justified in using every diagnostic tool at his or her disposal. In the 1960s, for example, a few workers at an Israeli dynamite factory became ill with acute hemolytic anemia. In this condition, the walls of red blood cells dissolve, making it difficult to transport oxygen through the body. The ailing workers were immediately transferred to another part of the plant, but plant officials were unable to pinpoint the cause of the mysterious outbreak until years later. Then researchers using newly developed genetic screening techniques traced the illness of these employees to G-6-PD deficiency, a polymorphism known as favism. People born with a pair of G-6-PD-deficient genes, most frequently those of Mediterranean descent, can suffer hemolytic anemia as a result of exposure to chemicals contained in the fava bean, as well as to some antimalarial drugs and other substances. In this case, the culprit was TNT. The factory gradually lowered exposures over the years, and G-6-PD-deficient workers are no longer at risk.

Genetic screening tests could also be used to inform workers with particular genetic anomalies that they are at increased risk of disease. The decision whether to accept that increased risk should be up to the worker. The employer could also provide special protection to susceptible workers, or generally reduce exposures in the workplace.

These uses, of course, presume the existence of sound scientific evidence linking the genetic trait to disease under particular working conditions. So far no such links have been found, although some might be discovered within the decade. In its 1982 report, the OTA mentioned as promising candidates for research and diagnostic use tests for G-6-PD deficiency and other types of susceptibility to chemicals that might interfere with the normal function of red blood cells. Also included in the OTA forecast were tests for serum alpha-1-antitrypsin deficiency, which is linked to emphysema.

The use that has drawn the most fire is the suggestion that employers might use the results of genetic screening to exclude so-called "hypersusceptible" workers. Opponents of genetic screening raise the spectre of cadres of unemployable genetic "misfits." They also suggest that employers might prefer to deal with health hazards by screening out those most likely to get sick rather than taking on the more expensive task of cleaning up the workplace. While the likelihood that we will create a class of genetic undesirables is small, there is no question that genetic screening, like any scientific or technological intervention, could be misapplied.

When industry wants to screen the few rather than protect the many, it should be prepared to make a strong case for its choice. Short of a catastrophic risk, where workers are virtually doomed to die if they choose to work under conditions of special hazard, U.S. companies should *inform* workers and leave the choice to them. Such a policy would be consistent with our nation's legal and political traditions of valuing individual freedom and choice.

Health risks, of course, are among several factors influencing people's job choices, and companies must avoid making paternalistic decisions about how individuals should weigh those risks against other factors such as alternative jobs and family responsibilities. But neither should companies fail to

Some employers might prefer to screen out those most likely to get sick rather than clean up the workplace.

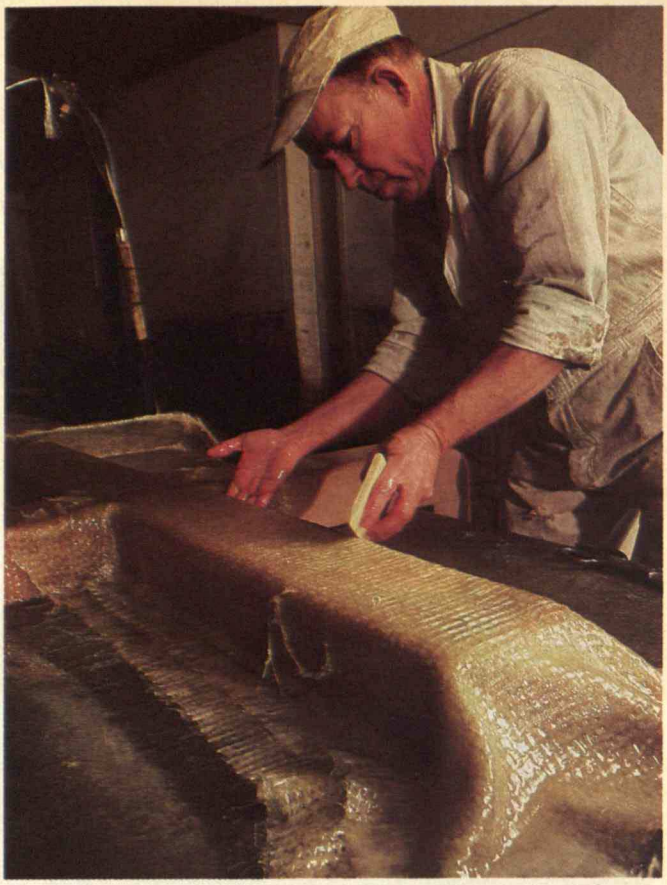
The potential benefits of applying genetic testing to the workplace are enormous. Such techniques could be used to determine safe levels of exposure to chemicals and radiation. But companies might also use the test results to exclude "hypersensitive" workers. Here a worker handles the radioactive materials used in making medical isotopes. These radioisotopes are an important diagnostic tool used to trace the chemical activity in human organs.

provide safe workplaces on the grounds that people can simply refuse to take a risky job, and that their acceptance of a job implies rational consent. When employment choices are severely limited, workers may in fact feel they have no reasonable alternative. Thus, in cases where workers ignore information about significantly heightened risk, companies should change the circumstances that would prompt them to accept eventual illness or death. Industry, for instance, could offer more attractive job alternatives and perhaps even counseling to help employees through difficult times.

Like screening, genetic monitoring is fast becoming a useful technology because of recent scientific advances. For instance, molecular biologists are beginning to piece together the relationship between genetic anomalies and Burkitt's lymphoma, a rare type of cancer in which white blood cells grow abnormally.

White blood cells transformed by Burkitt's lymphoma show a specific rearrangement of genetic material: parts of two chromosomes have broken off from their normal places on the DNA chain and changed places. The broken fragment from chro-

PHOTO: JOHN COLETTI, STOCK BOSTON



Hundreds of chemicals used in the workplace cause chromosomal damage in human cells or cancer in animals. Here an employee making the fiberglass trough for a water-flume ride applies a toxic resin by hand.

mosome 8 is now attached to chromosome 14, and the detached fragment from chromosome 14 has linked up with chromosome 8. Similar examples of such "reciprocal translocations" have been documented in most leukemias and lymphomas and in other types of cancers.

Why should this reshuffling of the genetic deck lead to cancer? The most plausible explanation focuses on oncogenes. These genes probably play an important role in fetal or early postnatal development. But when switched on in mature cells, they may transform normal cells into proliferating cancer cells. It so happens that the arm of chromosome 8 that breaks off and finds its way to 14 contains an oncogene called *c-myc*. In fact, this oncogene sits precisely at the breakpoint of chromosome 8 and hence at its new point of attachment to chromosome 14. The oncogene ends up right next to the gene that codes for a portion of a particular antibody molecule, which is produced in response to a foreign substance, or antigen. The white blood cells where this occurs are very active producers of this antibody molecule. The oncogene's proximity to the active antibody gene apparently results in the oncogene's being switched on as well. That, in turn, transforms white blood cells into cancerous lymphoma cells.

If this account is correct, evidence of chromosomal damage might be an early-warning signal that whatever is causing the genetic damage may later lead to cancer. Cancers typically reveal themselves only after 10, 20, or even 40 years. If the oncogene theory is correct for other cancers as well, and if reliable monitoring techniques can be developed to detect the likely presence of these oncogenes in altered chromosomal positions, then researchers will be able to identify potential cancers in humans without having to wait decades for the body count to begin. With genetic monitoring, companies could not only protect those workers not yet exposed, but perhaps could reduce the risk for a generation of workers already exposed.

Other evidence lends support to the scientific validity of genetic monitoring. Researchers have found that exposure to known carcinogens wreaks havoc at the subcellular level: it causes not only rearrangements within chromosomes but also structural damage to chromosomes, mutations in the DNA of white blood cells, abnormal sperm, and an increase of substances in urine that cause gene mutation. In addition, there is a perfect match between carcinogens

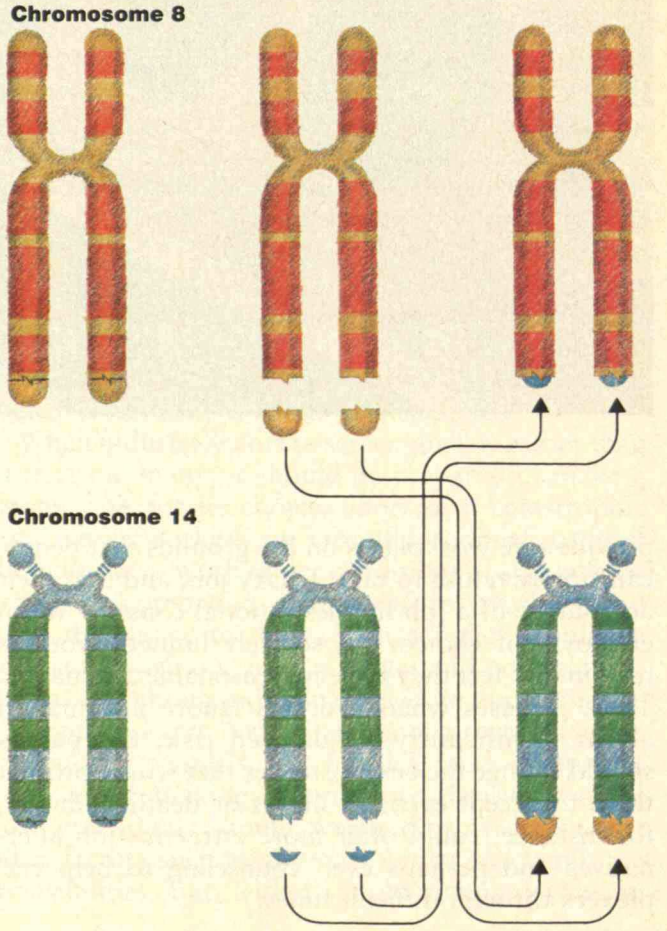


PHOTO: LIANE ENKELIS, STOCK BOSTON; DIAGRAM: OMNIGRAPHICS

on the list of the International Agency for Research on Cancer (IARC) and substances known to damage DNA—called "genotoxins." Of the 18 proven human carcinogens on IARC's list, for instance, all 5 that have been evaluated for chromosome damage in humans—arsenic, benzene, bis ether, chloromethyl ether, and vinyl chloride—have been shown to cause such damage.

The results of genetic monitoring should be seen as one piece of evidence that a substance is mutagenic or carcinogenic. Other information such as animal and in vitro assays are needed to make a final determination.

The ethical problems associated with genetic monitoring are less perplexing than those involved with genetic screening. Chemicals do not have moral rights and while employers do, those rights do not extend to willfully risking the health of their employees. Any time a chemical is identified as clearly causing genetic damage, workers should not be exposed to unsafe levels.

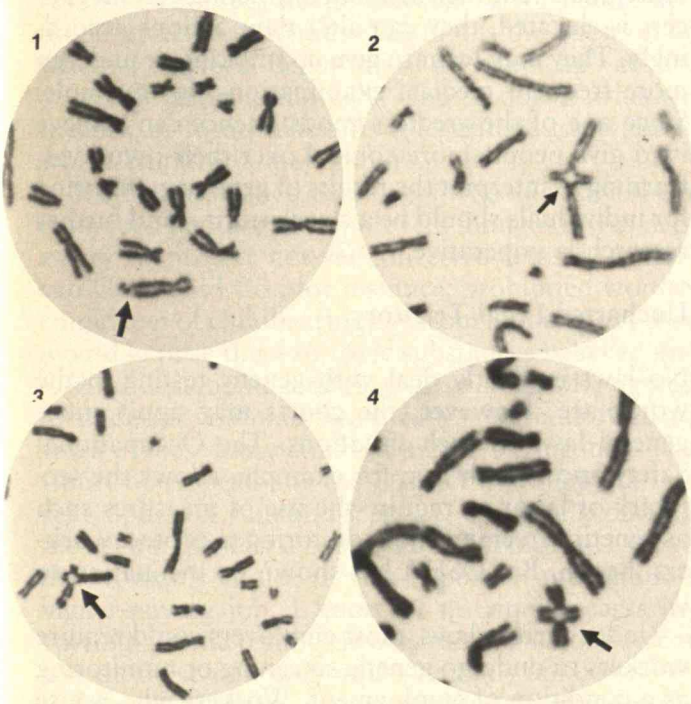
Still, genetic monitoring raises some serious ethical questions. Despite the strong inferential case, there is little direct evidence that genetic damage actually predicts the later onset of cancer. The only such evidence we have now is from the survivors of atomic explosions in Japan. Forty years after the bombs were dropped, researchers have established links between exposure to radiation, genetic damage, and cancer. But we cannot yet predict which specific individuals will develop cancer.

Lack of direct evidence plagues much research on the causes of cancer in humans. Geneticists have not had the opportunity to extend their studies over the 30 or more years known to be the latency period of some cancers. This leads critics such as J. Grant Brewen of Allied Chemical Corp. to maintain that there is "not one shred of evidence" directly linking chromosomal damage to any disease.

There's no reason to sound false alarms and divert our scientific and industrial resources for no good reason. Yet if genetic monitoring does yield plausible evidence that chemical exposures are likely to cause cancers 20 or 30 years hence, must we wait for the carnage to begin before we take protective action?

Genetic monitoring has already played an important role in reevaluating the hazards of one industrial chemical—ethylene oxide. A colorless gas used to sterilize medical supplies and equipment, ethylene oxide is frequently released from the wrappings of freshly sterilized material, as well as when doors to sterilizing chambers are opened. A 1978 study showed that the chemical adversely affected reproduction in animals, and in 1980 the American Hospital Supply Corp. disclosed that it had detected chromosomal changes in workers exposed to the gas.

The same year, Johnson & Johnson began a much larger study that revealed genetic damage among workers exposed to ethylene oxide in three plants. Johnson & Johnson immediately discontinued all use of the chemical at the plant where exposures had been highest. Shortly after, researchers found DNA damage in workers exposed to ethylene oxide at other companies as well. The significance of these findings was twofold: genetic damage was confirmed at more than one plant using several different techniques, and it was occurring at exposures well below the 50 parts per million (ppm) standard set by the Occupational Safety and Health Administration (OSHA).

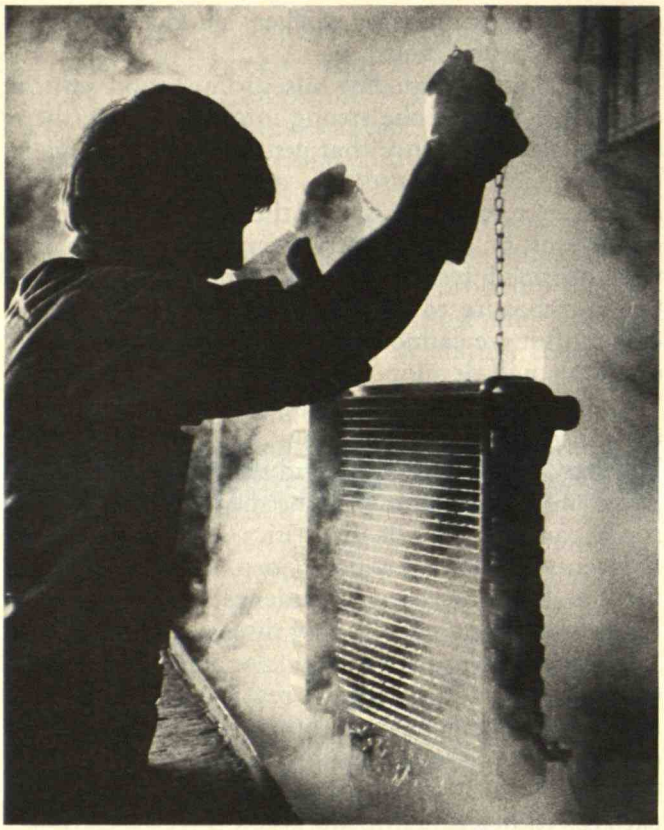


Subtle changes in human chromosomes may be early-warning signs of cancer. Left: One type of chromosomal rearrangement leads to Burkitt's lymphoma, a cancer of the immune system. Segments from chromosomes 8 and 14 break off and exchange places. This puts a cancer-causing gene near a normally active gene, causing malignant cells to reproduce excessively.

Other types of chromosomal damage are shown above. In 1, a fragment is torn off one chromosome. In 2, 3, and 4, two chromosomes exchange strands.

PHOTOS: UNIVERSITY OF TEXAS MEDICAL BRANCH

Firms would be in harmony with U.S. tradition if they informed workers about their risk and left the choice to them.



As a result of these findings, OSHA set a new standard that restricts long-term exposure to 1 ppm averaged over 8 hours. However, that means a worker still could be exposed to brief but high concentrations of ethylene oxide without exceeding the long-term limit. For example, a one-minute exposure to 480 ppm would not exceed OSHA's daily limit. In its reevaluation of the new standard, OSHA staff argued that intense short-term exposures were potentially dangerous in themselves, and proposed an additional limit on such exposures.

But on June 14, 1984, the day before the agency planned to announce the new short-term standard, the Office of Management and Budget (OMB)—responding to pressure from Union Carbide, the main manufacturer of ethylene oxide, the Health Industry Manufacturers Association, and others—opposed the standard in a letter to OSHA. OMB officials argued that the principal studies had "major flaws" and that tougher controls were not warranted. OSHA decided to reconsider and in January of this year, the agency announced it would not now limit short-term exposure to the chemical.

While independent reviewers did not agree that the studies had "major flaws," scientists did concede that the evidence does not conclusively prove that short-term exposures are any more dangerous than long-term low-level exposures. Regardless of the debate over short-term exposures, the ethylene-oxide case showed that genetic monitoring, in concert with other evidence, can be a valuable tool in setting public policy.

If genetic monitoring is eventually accepted as an early-warning system for an exposed group of workers, companies will have to decide what to tell individuals about their risk of developing disease. As our understanding of the relationship between genetic damage and disease grows, scientists may eventually learn to interpret such results for individuals. But for now, these interpretations are highly speculative. Scientists argue that drawing conclusions about individual risk may create false fears or, conversely, false reassurances. However, if we can tell individuals that their risk of contracting certain cancers is elevated, they can alter their actions accordingly. They may want to give up smoking or undergo more frequent medical examinations, for example. Since one of the greatest goods science can achieve is to give people more control over their own lives, learning to interpret the results of genetic monitoring for individuals should be a clear priority, and further research is imperative.

Uncharted Legal Territory

No laws explicitly deal with genetic testing in the workplace. However, the courts may apply more general laws to such situations. The Occupational Safety and Health Act, for example, allows the secretary of labor to require the use of measures such as genetic screening and monitoring to protect workers' health. But OSHA has shown no inclination to do so.

Under current laws, most employers could require workers to undergo genetic screening or monitoring as a condition of employment. Workers who refuse to participate could be in jeopardy of losing their jobs. Unions could include restrictions on genetic screening of employees and prospective employees in labor contracts. However, unions have not emphasized health and safety issues and, to my knowledge, no contracts now include such restrictions.

A broad—and as yet unanswered—question is

PHOTO: MICHAEL HAYMAN, STOCK BOSTON

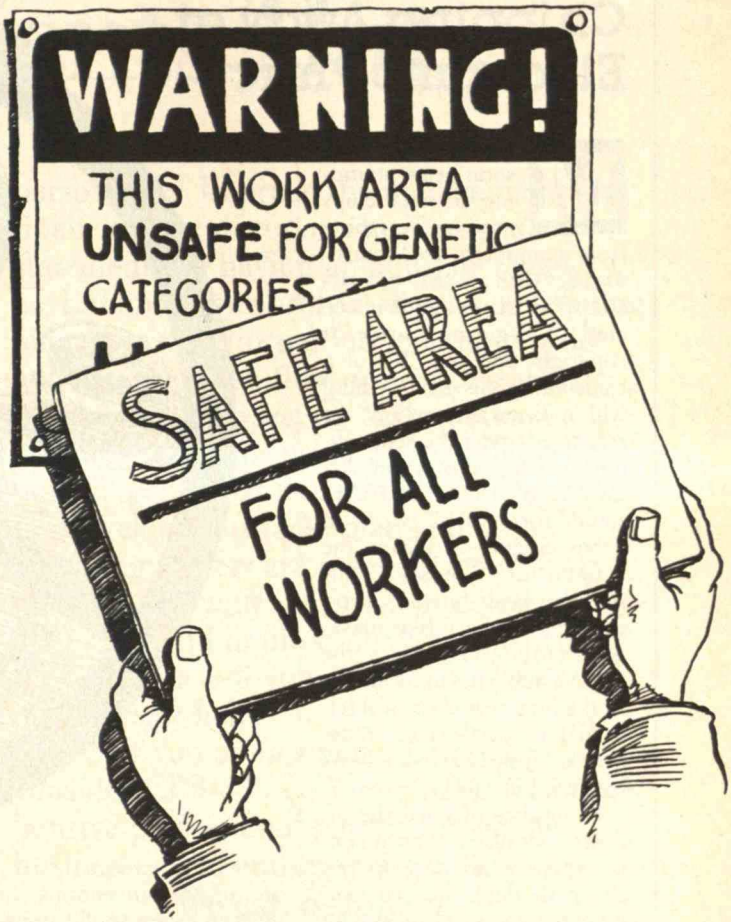
Millions of workers would benefit if genetic monitoring could be used to detect cancer-causing conditions early on.

whether excluding workers through genetic screening constitutes discrimination. A screening program for sickle-cell trait, even if it included all employees, would have a disparate impact on blacks. In the words of the U.S. Supreme Court, it would be "fair in form but discriminatory in operation." An employer who used the results of such screening to make hiring and placement decisions would have to prove that the test predicts the likelihood of future illness. The employer would also have to prove that the lower risk of future illness is a legitimate job qualification, or that excluding susceptible workers is a business necessity.

State or federal laws prohibiting discrimination against the handicapped might prevent workers from being excluded from jobs, but only if these laws apply to a particular workplace. For instance, the U.S. Rehabilitation Act of 1973 applies only to employers holding government contracts or receiving federal aid. Even then, the courts would have to resolve two issues in the workers' favor before upholding such restrictions. The first is the question of whether the legal definition of a "handicap" covers a specific genetic anomaly. The second is whether the risk of future illness is a legitimate issue about which employers may inquire.

Women have sued employers who excluded them from jobs because the employers thought it was necessary to protect not-yet-conceived fetuses. American Cyanamid Co., for instance, prohibited women employees of childbearing age from holding jobs that would expose them to toxic substances believed unsafe for developing fetuses. Only women who agreed to undergo voluntary sterilization were allowed to work in these hazardous but higher-paying jobs. The Court of Appeals for the District of Columbia last year upheld Cyanamid's policy, essentially placing the need to protect a possible developing fetus above the woman's choice to risk exposure and retain a higher-paying job. I know of no similar cases involving genetic testing; hence, the impact of current law on these new techniques remains unknown.

Though different, genetic screening and monitoring in the workplace both illustrate a fundamental truth about the use of technology: judging what we should do requires much more than simply knowing how to do it. At this time, there is no scientific evidence showing that genetic screening programs in American workplaces would benefit anyone. Using tests for diagnosis or research would be defensible,



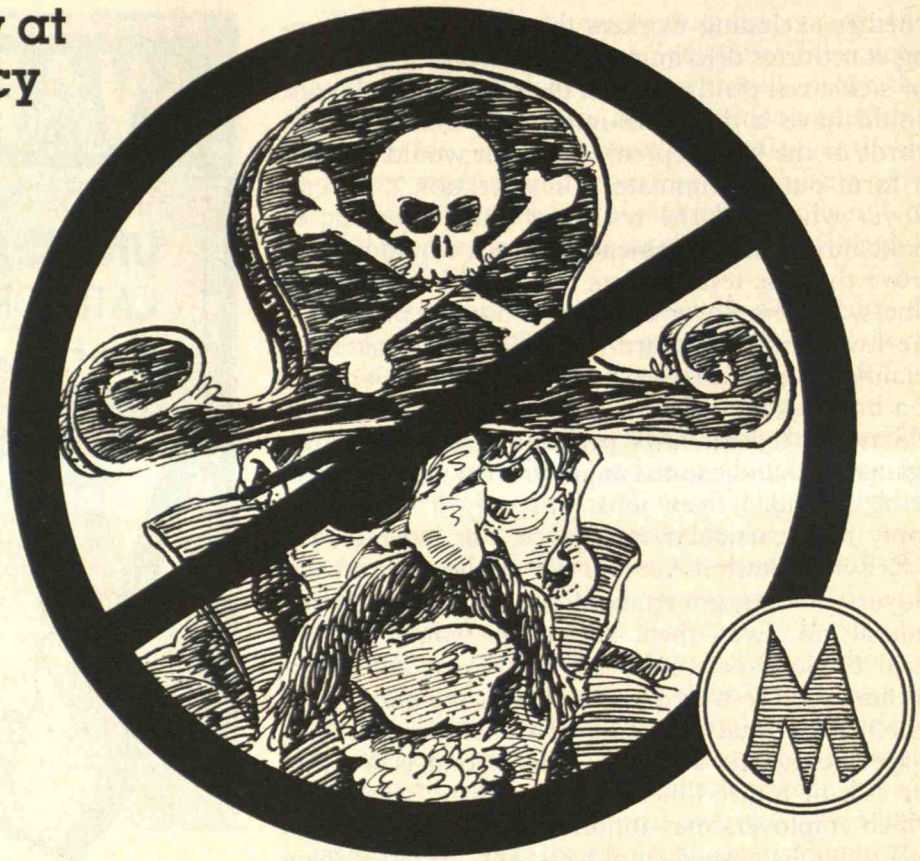
but such research must come under much closer scrutiny. However, using screening for exclusion or even for information is certainly not justified now.

In contrast, genetic monitoring has enormous potential as an early-warning signal for disease. When there is some, but not conclusive, evidence that workplace exposures are hazardous, the principal problem will be finding a balance between harm to individuals on the one hand and cost to producers and consumers on the other. But that is a balance worth trying to strike. Millions of American workers would benefit if genetic monitoring could be used to detect cancer-causing conditions in the workplace earlier than is now possible.

THOMAS H. MURRAY is associate professor of ethics and public policy at the Institute for the Medical Humanities, University of Texas Medical Branch, in Galveston. He codirected several research projects on ethical issues in occupational health at the Hastings Center, a New York-based institute examining ethical issues in medicine and science.

ILLUSTRATION: JON MCINTOSH

Chipping Away at Electronic Piracy



Manufacturers will soon begin stamping the microchips used in everything from computers to "smart" toasters with an "M" in a circle. Akin to the familiar circled "C" giving notice of copyright and the "R" of a trademark, this new symbol will indicate that chips are registered under the Semiconductor Chip Protection Act (SCPA) of 1984. The "M" stands for "mask" work: to define circuits on a chip, the manufacturer exposes a light-sensitive layer on the silicon through a stencil-like mask. Aimed to stop chip piracy, the SCPA establishes mask works as the first new class of intellectual property since trademark protection was legislated in 1881.

Piracy has plagued the industry because a typical chip is expensive to develop but cheap to duplicate. To generate the necessary masks, an unscrupulous firm need merely dissect a chip and photograph its circuitry. Thomas Dunlap, counsel to Intel, estimates that a chip costing $4 million to develop can be copied for $100,000.

No one has accurate figures on the magnitude of chip piracy, but everyone in the industry agrees that it is widespread. "We felt that we were potentially losing tens of millions of dollars a year to pirated chips," said Dunlap. Intel has sued several pirates but is now licensing the chips to them and declines to reveal what, if any, damages were involved.

Finding a legal solution to the piracy problem wasn't easy. Patent protection didn't help: patents are granted only on original inventions, and most chips are applications of well-understood principles. Thus, the design that makes one chip better than another generally isn't patentable, says Intel's Michael Glenn.

Chips versus Books

Legislation introduced in Congress in 1979 and 1983 sought to extend copyright protection from traditional literary works to chips. This idea initially looked feasible. Since the blueprints for a house can be copyrighted, so, by extension, can the masks to make a chip. Yet a copyright on blueprints merely prevents outsiders from reproducing (and selling) the actual plans, not from building the house described by the plans. By extension, a mask copyright only prevents pirates from reproducing the mask, not from manufacturing the chip.

Legislators considered extending copyright protection to the pattern of circuitry on the chips themselves, but the further they delved, the more byzantine the problems appeared to grow. The industry distinguishes between directly duplicating and selling chips, which constitutes piracy, and the accepted practice of "reverse engineering": reputable manufacturers routinely dissect the circuitry of their competitors' chips to assess their innovations and exploit any new general design principles. But to learn what is on chips, companies must use the same techniques of copying circuits that pirates do. In other words, manufacturers need to be able to photograph competitors' chip circuits to analyze them, but must not be allowed to reproduce and sell them.

Unless it was severely contorted, copyright law would achieve precisely what the manufacturers do not want. Stretching it to cover chips gave even lawyers nightmares. Moreover, copyright law has always denied coverage to articles that are inherently useful, such as a sculpture that is also a bottle—or a chip.

"A mask is not a book," concluded Rep. Robert Kastenmeier (D-Wisc.), chairman of the House Subcommittee on Courts, Civil Liberties, and the Administration of Justice. He introduced the SCPA, giving unique protection to chips.

ILLUSTRATIONS: JON McINTOSH

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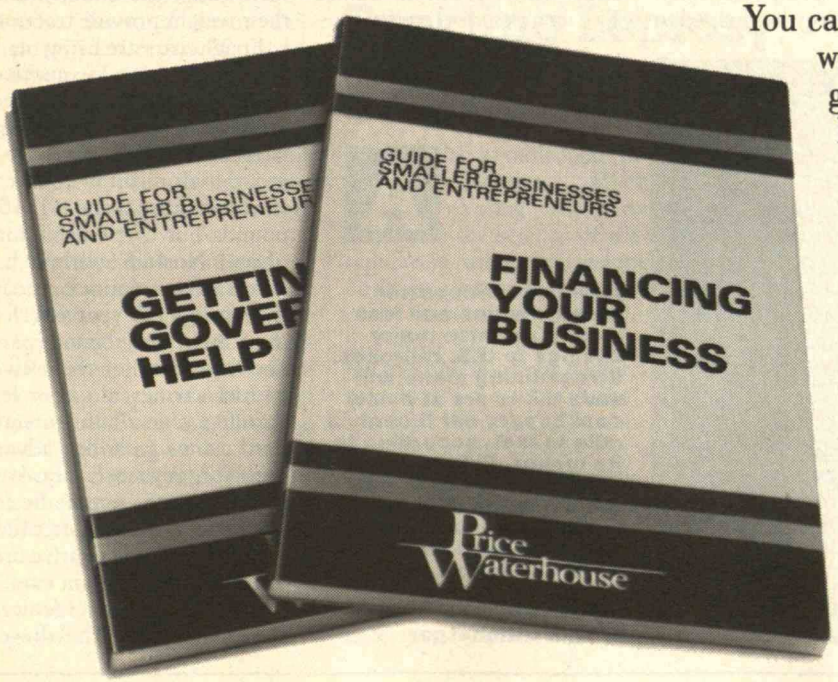

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The law grants the developer of a chip the exclusive right to produce and sell it for 10 years, but allows others to copy its circuits "solely for the purpose of teaching, analyzing, or evaluating" its design. According to a Senate committee report, new chips with features garnered through reverse engineering can be protected under the act, as long as they required "significant toil and investment" beyond that involved in analyzing the original chip. Intel's Dunlap says he's convinced that the distinction can protect both chips and the industry's interest in reverse engineering.

The legislation also includes an "innocent infringement" clause to protect, for example, an automaker who unknowingly uses a pirated chip. If that happens, the car will not have to be taken off the showroom floor, says Glenn. Innocent infringers will, at worst, be required to pay reasonable royalties.

U.S. chip makers have felt all along that they needed protection particularly against pirating by Japanese firms, and the legislation has apparently already had that effect, says Dale Hatano of the Semiconductor Industry Association: as soon as it was clear that the SCPA would pass, the flow of pirated Japanese chips dried up.

The act also tries to foster international protection of microchips: foreign-made chips can be protected in the United States only if the country they come from agrees to reciprocate. The Japanese have now started working on laws to protect microchips, and Hatano says there have been "nibbles" of interest from other countries as well.—*David Kennedy* □

Railroads Want Technology

A string of 100 or more dirty freight cars dragged across the countryside by a growling locomotive is hardly the popular image of high technology. But railroads are incorporating sophisticated new technology every day. At a recent meeting of the American Society of Mechanical Engineers, speakers explained some of the further improvements that engineers could make in rail equipment and operation.

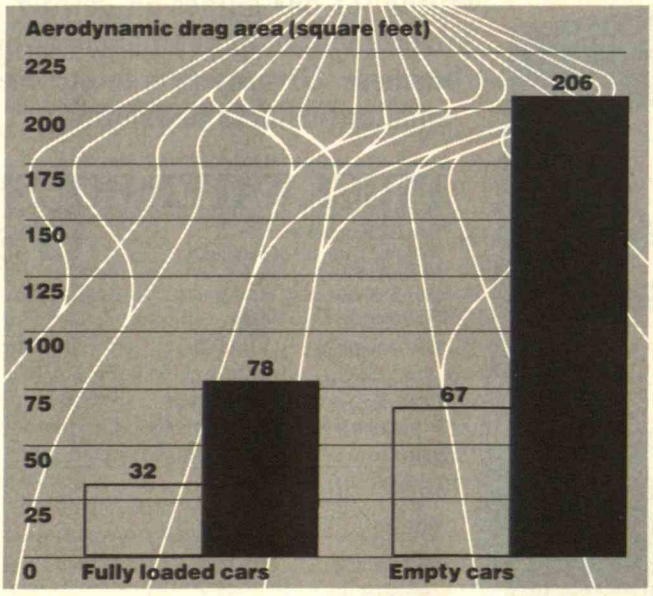
As engines have become more powerful and freight cars stronger, loads have increased—a single car may now carry over 100 tons. New metallurgy has helped to make rails stronger and beds more resilient to accommodate these loads. However, rails must still be replaced before they are worn out—before friction with the wheels has eroded too much steel—because fatigue cracks develop from continual flexing under the weight of the trains. The cracks are easily detected, so they pose no safety threat, maintained Hobart L. Scott, Jr., vice-president and chief mechanical officer of the Norfolk Southern Railway, but replacing rail is costly.

Roger K. Steele of the Association of American Railroads (AAR) hopes for metallurgical improvements to make rail more resistant to fatigue cracks. And Scott believes that by analyzing rail-system operations, engineers can establish the optimal balance between the economies of heavy hauls and their cost in new rail.

The AAR has found that railroads can save nearly $700 million a year in fuel costs by using lubrication to reduce the friction between wheels and rail. Of course, too much lubrication would result in too little friction under the drive wheels. William J. Harris, Jr., vice-president for research of AAR, suggested a solution: let the locomotive generate electricity, but place small drive motors on the axles of loaded cars throughout the train, letting their weight provide traction.

Freight cars are being made lighter, allowing locomotives to pull more weight in cargo. Pullman Standard is offering railroads "Pegasus"—a mostly aluminum coal car that weighs only 41,400 pounds but carries 111 tons of coal. Norfolk Southern has a fleet of aluminum coal cars that weigh 22 percent less than their steel counterparts and have paid for themselves in fuel savings alone in less than five years. Pullman Standard claims an added advantage for Pegasus: improved aerodynamics—especially for empty cars. But Scott called for "still more innovative uses of lighter materials in cars."

Locomotive manufacturers need to replace the diesel-



New cars with better aerodynamics and less weight promise major savings to U.S. railroads. Streamlining alone will save the users of a new coal hopper car 5 cents a mile in fuel, according to its maker, Pullman Standard. Among other new technologies proposed for U.S. railroads: new steam-powered locomotives and longer-lived rail.

□ **Pegasus**
■ **Conventional car**

DIAGRAMS: OMNIGRAPHICS

electric engine, just as the diesel replaced the old piston-driven steam engine, said Norfolk Southern's Scott. The diesel has seen remarkable refinements such as computer controls that open the throttle just enough to maximize "adhesion," thus keeping drive-wheel slippage to a minimum. But the diesel is maturing, and improvements are having smaller and smaller effects on economy and reliability. Also, diesel fuel remains costly.

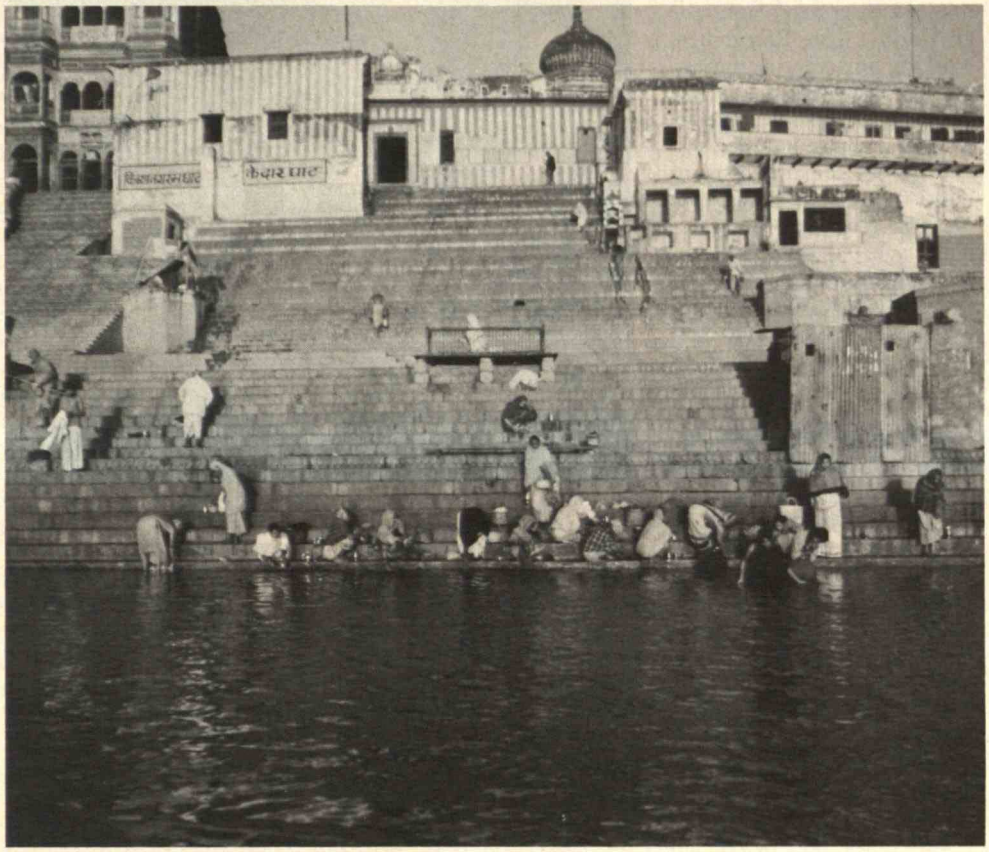
New Locomotive

Serious research on coal-burning locomotives ended in the mid-fifties, and only recently have new efforts begun. American Coal Enterprises of Lebanon, N.J., is working on a streamlined, microprocessor - controlled version of the old piston-driven steam locomotive. Scott favors, in effect, a coal-electric locomotive: coal would supply electric power, which would in turn drive the wheels through motors on the axles. National Steam Propulsion Co. in Woburn, Mass., is working on such a locomotive. The timetable is uncertain, but Robert B. Claytor, chairman of Norfolk Southern, believes that sooner or later railroads will return to coal.

Finally, many railroad executives are mesmerized by visions of robots, and in some applications they will be cost-effective—handling freight, sorting cars in switching yards, and welding, cleaning, and painting in car repair shops. But though the U.S. rail system is vast, says Carl D. Martland, an M.I.T. railroad expert, the uses for robots are few and the numbers needed are small.

—John Mattill □

Leprosy victims bathe in the holy waters of the Ganges River, as it flows through the sacred Hindu city of Benares.



Tackling Leprosy: One Scientist's Dilemma

As a molecular biologist, Rick Young works on the science of manipulating pieces of genetic code in yeast. But unlike many basic researchers, he has seen firsthand what a microscopic piece of bacteria can do to a human being's life. Rick Young has become involved in the effort to cure the ancient and stubborn disease of leprosy, and it has changed his view of his work.

He still defends the methodical pace of basic research as "absolutely necessary," yet he can't help a feeling of frustration. He understands why some doctors seek the instant cure in a desperate attempt to relieve their patients' suffering. And for the first time in his life, Young, who holds a joint faculty position at M.I.T. and the Whitehead Institute for Biomedical Research at the tender age of 30, knows what it is like to feel inadequate.

Young's concern with leprosy began largely by accident. While doing postdoctoral work at Stanford University, he and a colleague devised a new technique that allows molecular biologists to isolate the genes that code for antigens—markers of an invading virus or bacterium. This technique is particularly helpful in making vaccines, since they confer immunity by introducing a foreign antigen and tricking the body's natural defense system into reacting against it. The body rushes to produce antibodies and immune cells that can seek out and destroy that antigen. Thus, in the event of an actual infection, the body already has a built-in defense against disease.

Shortly after Young and Ronald Davis published their research on this new technique, public-health researchers contacted him for help in developing a vaccine for leprosy. Unlike more versatile laboratory bacteria, *M. le-*

PHOTO: RICK YOUNG

Rick Young in his lab at the Whitehead Institute, with technical assistant Julie Sexton.

prae, the parasitic bacterium that causes leprosy, cannot be grown in a dish. Researchers working on a vaccine have to "grow" these bacteria in live animals—in this case, wild armadillos, whose immune system allows the organism to flourish. A vaccine made from bacteria grown in these animals is being tested on humans in Venezuela. But even if it proves effective, armadillos are not plentiful enough to supply sufficient vaccine to inoculate the world.

"I became intrigued by the idea that I could test the power of recombinant-DNA technology by attempting to isolate the genes of the *M. leprae* antigen and develop a vaccine to eradicate leprosy," Young says. "It was an interesting intellectual problem."

But no sooner had Young tackled that intellectual problem than he received a call from Barry Bloom of Albert Einstein Medical Center in New York. Bloom chairs the steering committee for the immunology of leprosy at the World Health Organization (WHO). "Barry let me know how serious a problem leprosy is in developing countries," Young says. "Basically, he charmed me onto the steering committee."

A Disease of the Soul

What Young doesn't mention is that the involvement of a molecular biologist in a public-health problem of this sort is unusual. Basic researchers have traditionally kept their distance from the frantic immediacy of medicine. And most are working on treatments for the relatively rare diseases of affluent America: Factor VIII, a component of blood that can be used to treat hemophiliacs; human growth hormone, which could possibly be used to treat growth deficiencies in children; and interferon, a possible anticancer agent.

Although leprosy is relatively uncommon in the United States, it is widespread in developing countries, with 12 million cases reported around the world. The people of most Third World countries retain an abiding fear of the disease, and leprosy victims are often cast out of their homes and exiled for life to leper colonies.

The leprosy bacterium attacks the nerve cells of the skin and the peripheral nervous system, causing a loss of pain sensation and, in some cases, loss of control over muscles in the hands and feet. "Since leprosy victims can't feel pain, they don't really notice when they damage their hands or arms, and their wounds aren't treated," Young explains. As a result, they easily pick up infections, eventually becoming laden with scar tissue and scabs. Tissues in the hands and feet are gradually deformed and destroyed by repeated injury, rather than by the leprosy organism itself. But contrary to age-old belief, their hands, fingers, toes, and feet do not rot and drop off.

Last year Young traveled to India for a meeting of the WHO steering committee on leprosy. In touring India and later in hiking through Nepal, he was surprised at the number of lepers he met. Many were still trying to hide the disease from family and friends; others had already committed themselves to a life of self-exile.

"I wanted to convince them that leprosy is a human disease with a known cause—that they don't have it because they've offended God," Young says, his voice full of bewilderment. "But they didn't understand my viewpoint and I didn't understand theirs. This was something my academic training had not prepared me for."

No Quick Cure

Seeing such suffering presented Young with another dilemma: "My training tells me to be thorough, systematic, and comprehensive," he says. "Yet there is also a desire to seek short-term solutions that may only be Band-Aids." For example, doctors conducting the patient trials in Venezuela must use a skin test to evaluate the efficacy of their vaccine. In that test, very small amounts of the leprosy antigen are injected into the patient's arm; swelling near the injection means that the vaccine has been effective in triggering the production of immune cells. The skin test now being used is only marginally adequate, Young says, and some of the new antigens that he and colleagues have isolated could help to improve it.

"As basic scientists, we'd like to isolate all the genes for all possible leprosy antigens and test them, rather than looking further into the few genes we've already isolated," Young says. "And that's the correct approach—even though it may take longer to develop an efficient test that way."

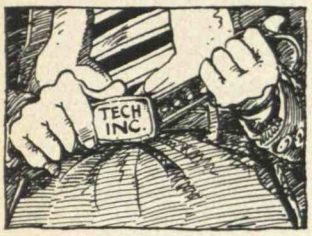
Young plans to take the *M. leprae* genes he has isolated and insert them into a bacterium that is now being used to produce an effective vaccine for tuberculosis. He hopes that the new genetically fused organism will yield as potent a vaccine for leprosy.

The quest for an effective vaccine is particularly urgent because the leprosy organism is growing more and more resistant to dapsone, the most widely used anti-leprosy drug. As many as 50 percent of the new patients in some Asian clinics are showing up with drug-resistant leprosy.

"In developing a vaccine, we're not necessarily going after solutions for people who have the disease today," the molecular biologist says and then suddenly leans forward, gripped by another thought. "But once we develop a vaccine that confers life-long immunity, we could rid the earth of leprosy—just as was done with smallpox."

—*Alison B. Bass* □

PHOTO: ANDREW ROOS



Tax Reform and Technology

Soon after the Treasury Department launched its tax-simplification plan early this year, technology entrepreneurs joined the bandwagon of special pleaders. One aspect of the plan seemed a sure boon: retaining the 25 percent tax credits for increases in R&D expenditures. That was lauded by some 50 economists and engineers convened late last winter in Washington by Professor Dale Jorgensen and Faculty Fellow Ralph Landau of Harvard University.

The Treasury's plan to end the tax credits of up to 10 percent for capital investment and the deductions for rapid depreciation of new capital equipment drew mixed reviews. Data released by Citizens for Tax Justice, which surveyed 250 large U.S. companies, show little correlation between the tax breaks that corporations have taken and the amount of capital investments they have made. In fact, the 50 with the lowest tax rates decreased their investment by 21 percent, while the 50 with the highest rates increased their investment by 4 percent. Thus, Robert S. McIntyre, director of federal tax policy at Citizens for Tax Justice, applauded the Treasury's plan to eliminate these tax "loopholes."

But call them loopholes or incentives, they can help high-tech entrepreneurs. High interest rates already hamper innovators' quest for capital; ending these tax breaks would do more harm, charged several conferees.

The Treasury's plan to eliminate another tax break—the low rates for capital gains—drew unanimous cries of anguish from symposium participants. Since 1978, capital gains, such as those one hopes to achieve by investing in a start-up firm, have been taxed at a lower rate than other income; today 60 percent of capital-gains income is exempt from tax. This policy is credited with unleashing an outpouring of venture capital into the small, young firms that are a major source of innovation.

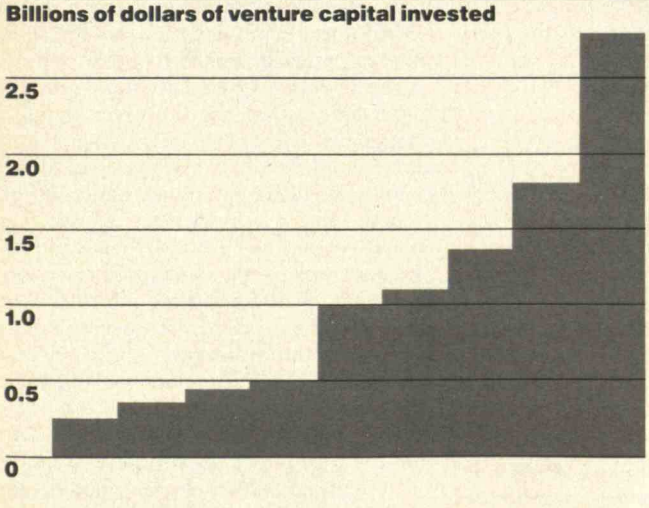
Lifeblood for Start-Ups

Venture-capital commitments soared from $39 million in 1977 to $600 million in 1978, according to Burton J. McMurtry of the National Venture Capital Association. By 1983 the total was over $4 billion. McMurtry is convinced that an increase in the capital-gains tax will reverse this trend, draining away the funds that are the lifeblood of start-up firms: "If start-ups don't start, the flow of technology will become a trickle."

However, the preferential treatment of capital gains has also reduced taxes on income from many less productive investments, such as those in real estate. An investor can buy a building and use rapid depreciation to secure "almost scandalous" tax breaks, charged Bruce Scott, professor at the Harvard Business School, in the *New York Times*. When the building's value has gone up, the investor sells it, paying only low capital-gains taxes on the profits. If the Treasury maintains the low capital-gains tax rate, Professor John B. Shoven of Stanford suggested, only those who invest in true venture-capital projects should be allowed to claim it.

Treasury's tax-reform proposal attracted praise from the Washington conferees for its plan to end the double taxation of corporate dividends (once as part of corporate income, once after they have been paid to stockholders). This measure wouldn't affect venture capitalists who do not receive dividends. But for companies that do pay dividends, reducing taxes on them might offset higher taxes on capital gains from the sale of stocks, thought some economists.

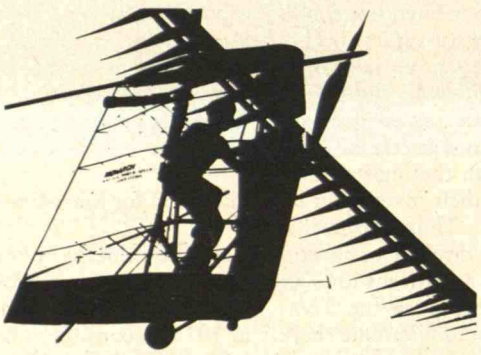
But Jack L. Rivkin, chairman of the Executive Group at Paine Webber, warned against losing track of the forest for the trees. The main influence on the flow of capital into the venture sector is the overall vitality of the economy, he said. And he expressed optimism that the ingredients are in place for a long period of growth—the major risk being lack of action on that familiar villain, the federal budget deficit.—*John Mattill* □



Since 1978 capital gains, such as those investors hope to realize by putting money into start-up firms, have been taxed at a lower rate than other income. This policy is credited with increasing venture-capital investments in the young firms that are a major source of technological innovation. Thus, entrepreneurs were disappointed to hear that the Treasury's tax-simplification plan would again raise rates on capital gains. (Data: Venture Capital Journal, Wall Street Journal, OECD Observer.)

Capping a seesaw struggle, replete with early-morning test flights shrouded in secrecy, Monarch captured the world speed record. The real winner, however, is the field of human-powered aircraft.

Mach .03 or Bust



BY JOHN S. LANGFORD

PEDALING at slightly more than 90 strokes a minute, Frank Scarabino swings the *Monarch* through the last wide turn. Condensation is heavy inside the Mylar-encased cockpit and Frank can barely see as he heads for the crepe-paper streamer marking the finish for one of the world's most unusual air races.

The idea that he might be attempting to set a world speed record would hardly occur to an unknowing bystander: the diaphanous aircraft barely seems to be moving. The idea that this might be a *successful* attempt is almost as foreign even to those of us involved with the project. Yet there is *Monarch*, moving slowly but moving nonetheless—lining up on runway 5/23 of Hanscom Field, just outside Boston. A wave of realization sweeps the field: "This is it! He's really going to make it!" As Frank pulls the aircraft into a gentle climb and soars across the finish line, pandemonium breaks loose. People yell, leap, and cry as the aircraft touches down and rolls to a stop.

As team members help Frank out of the zippered cockpit, the two official timekeepers walk slowly toward each other. They exchange glances, wordlessly saying "you go first, my watch might be a little off." But there is no disagreement: after a year of work and 6,000 hours of volunteer labor, *Monarch* has missed the Kremer world speed record by 430 milliseconds.

An eerie silence develops as the word spreads. The only other time the field has been this quiet was nine months earlier, after another pilot plowed the aircraft into the ground, freezing everyone until team members ripped open the wrecked cockpit and retrieved him unharmed. On this morning in early May 1984, however, *Monarch* is in better condition than ever. And as we roll the gangly aircraft gingerly to its hangar, an apprehensive confidence begins to return. We've clearly solved earlier technical problems, and Frank and the *Monarch* have proven they can fly the prescribed 1,500-meter course.

The only question now is whether our M.I.T. team will be the first. On the West Coast, an aircraft called the *Bionic Bat* is flying almost daily and has already made repeated attempts at the speed record. Each day sees tensions mount.

Fostering Flight

The unlikely marriage of aerodynamics and athletics that makes possible human-powered flight has been fostered for the past quarter-century by a series of prizes offered by British philanthropist Henry Kremer. Administered by the Royal Aeronautical Society (RAeS), the Kremer competitions have produced some of the most unusual contraptions ever to be called aircraft.

The first contest, announced in 1959, offered 5,000 pounds to the builders of a human-powered aircraft that could fly a figure-eight pattern around two markers half a mile apart. It took almost 18 years—and an increase in prize money by an order of magnitude to 50,000 pounds—before the *Gossamer Condor* succeeded. A California group headed by engineer Paul MacCready designed *Condor* and Bryan Allen pedaled it to victory.

The second contest offered 100,000 pounds for a flight across the English Channel, but it could hardly have been called a competition. MacCready's group had the *Gossamer Albatross* flying six months before the rules were even publicly announced, and on June 12, 1979, the aircraft captured the largest prize in aviation history (*see "How the* Gossamer Albatross *Conquered the Channel," May/June 1981, page 68.*) MacCready's name became synonymous with human-powered flight, so when the RAeS announced the Kremer World Speed Competition early in 1983, all eyes naturally turned to California.

The new prize offered 20,000 pounds—about $33,000 at the time—for flying a triangular 1,500-meter course in less than three minutes. Additional prizes of 5,000 pounds would go to anyone bettering the record, once set, by 5 percent. Winning would require an airplane that could fly twice as fast as the *Gossamer*-class aircraft. But for the first time the rules also allowed onboard energy storage: the pilot could cache his or her own energy, by any means, during a ten-minute period before the flight.

MacCready assembled a team and launched an effort. In July, a newsletter on human-powered vehicles quoted him as announcing that he would claim the prize before the summer was over, since "we can build a wing in a week, with parts

JOHN LANGFORD is working toward a PhD in aeronautics and public policy. He is now at the Institute for Defense Analyses in Alexandria, Va., and was an engineer at Lockheed Corp. from 1979 to 1984.

PHOTO: E. DONALD WEINER

The *Monarch* takes to the air during an early test flight. Powered by a .5-horsepower "engine"—the pilot pedaling for all he's worth—the aircraft achieves a speed of 21 miles per hour.

PHOTOS: STEVE FINBERG

that we have just lying around."

MacCready's claims were greeted with nervous skepticism in the basement laboratories of M.I.T.'s Department of Aeronautics and Astronautics. There, a team of graduate and undergraduate students was laboring to construct the *Monarch*, M.I.T.'s entry in the speed competition.

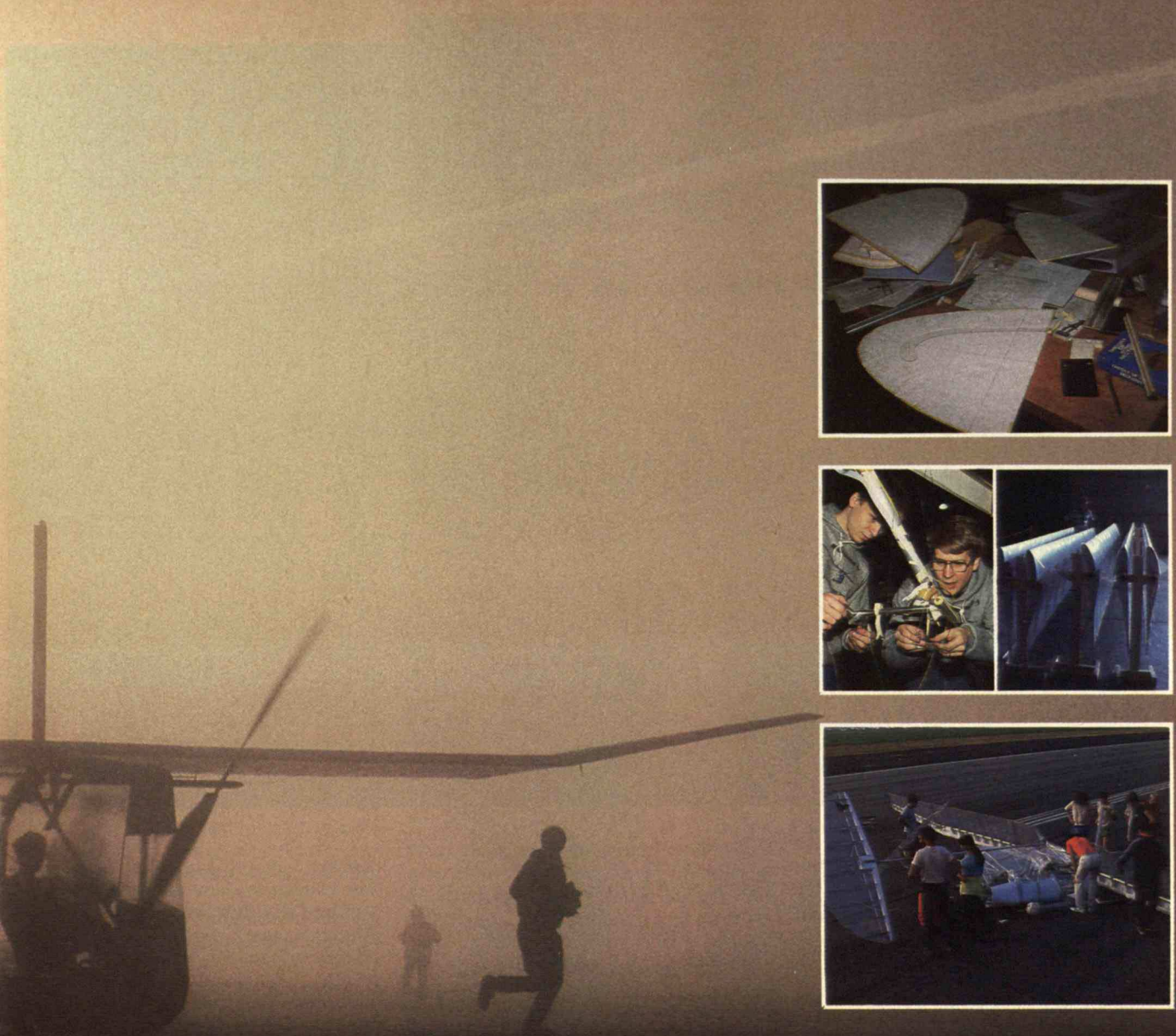
Between 1969 and 1979, several generations of students designed and built three previous aircraft, more or less inspired by the Kremer Prizes. Two Biplane Ultralight Research Devices—*BURDs I* and *II*—were built for the figure-eight contest. Although neither one ever flew, the planes made several conceptual contributions to the field of human-powered flight. They also provided students with the opportunity to translate theoretical calculations into hardware while experiencing all the pitfalls thereof.

The third aircraft, *Chrysalis*, proved more airworthy. Built in 1979 with an eye on the cross-channel prize, the plane made 350 flights with 44 pilots before being disassembled. *Chrysalis* was intended to be not so much an end product but, as its name implied, a stage in development. As it turned out, the next aircraft was not to emerge for another four years.

Mark Drela and I helped build *Chrysalis* as undergraduates, and we were both in graduate school when the speed competition was announced in 1983. Joined by Juan Cruz, Scott Clifton, and Steve Finberg, we launched a new campaign in May—soon dubbed *Monarch*—and assembled a team that eventually numbered more than a dozen people. Necessity decreed that our design emphasize rapid construction and low cost. The Aero and Astro Department made clear that it would provide little or no funding initially, and that we had to vacate the basement labs by the end of the summer. Team members kept the project afloat financially through July, until it seemed certain the aircraft would become a reality, and then the department took over support. (Expenses eventually totaled about $5,000.)

We had to make a series of trade-offs in designing *Monarch*'s wing, since it would strongly determine the aircraft's weight, speed, and power. For example, increasing the plane's design speed significantly reduces the area of the wing; but it also increases the drag that retards the plane's motion, and thus boosts the power needed for flight. Sizing the wing correctly was vital, because the power of *Monarch*'s "engine"—the pilot—is fixed. An underperforming jetliner can be retrofitted with more powerful engines; an underperforming human-powered aircraft sits on the ground.

We decided on a design speed of 21 miles per hour—just enough to capture the first prize. That implied a wing area of about 175 square feet for the *Monarch*, contrasting with 750 square feet for *Chrysalis*, which flew at just 10 miles per hour. To minimize the drag, we adopted a wide (62-foot) wingspan, constructed from aluminum tubing that we made even thinner than normal by etching in hot baths of lye and acid. By itself, the wing's main spar could not even support its own 18-pound weight. But four strategically placed steel



bracing wires enabled the spar to support twice the weight of the loaded aircraft.

To provide onboard energy storage—the new technical twist in the rules—we developed an electrical system. (We rejected stretched-rubber storage as too heavy and a flywheel as too complicated and potentially dangerous.) The pilot pedals a small generator to charge up a set of batteries, which then drives an electric motor that helps turn the propeller during flight. Electronic wizardry enabled us to combine the motor and generator in a single unit, thus obviating the need for a gearshift mechanism, which would have added both weight and mechanical complexity.

We built the aircraft in pieces, which we moved to a hangar at Hanscom Field for final assembly. *Monarch* rolled out for the first time on August 4, but was damaged during a taxi test. At dawn on Sunday, August 14, the hangar doors opened again. Eighty-eight days and 4,300 hours of work after construction began, *Monarch* was ready to fly.

Initial tests, under the hands of an experienced pilot, went well. But when we turned over *Monarch* to a stronger athlete, whose extra power the aircraft needed, he crashed. Damage was serious and the team was demoralized.

The Plot Thickens

Unknown to us at the time, MacCready's new aircraft, the *Bionic Bat*, made its first test flight the morning after *Monarch*'s crash. Intended to fly at more than 30 miles per hour, the *Bat* was much smaller than *Monarch*, with a 40-foot wingspan and a wing area of about 120 square feet. Instead of aluminum tubing and wires, the *Bat* had a structure made of graphite-epoxy composite material (which we considered ideal but rejected because of cost). Like *Monarch*, it used an electrical energy-storage system, although it was substantially different in detail. The Kremer Competition had become a real race.

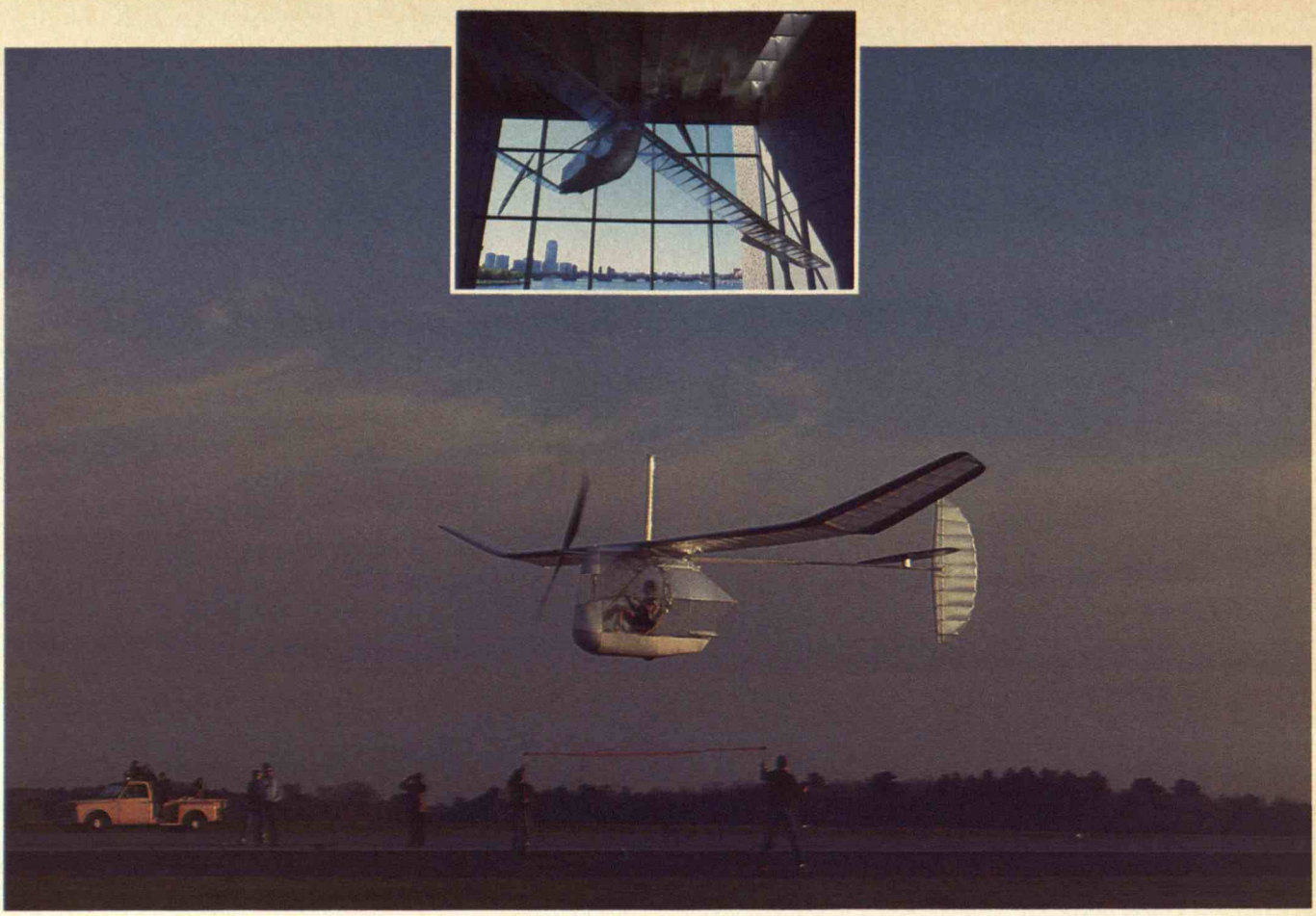
Our team recovered from *Monarch*'s crash and tackled a full-scale repair. We taxi-tested the rebuilt aircraft on August

Test flights often took place at dawn to capitalize on calm air and deserted runways.

***Monarch*'s student designers had to combine theory and hands-on experience to produce the optimum balance of speed, weight, and power (top).**

The team built the aircraft's Mylar-covered wing, spanning 62 feet, in pieces in M.I.T. basement labs, and moved them to the hangar for assembly (middle, right). John Langford and Mark Drela work on the pilot's controls (middle, left).

The pilot emerged unhurt from this serious crash, but it almost put the *Monarch* team out of the running (bottom).



28, and on September 2 it flew again. Frank Scarabino, a hockey player and experienced pilot, was now in the cockpit. At 160 pounds, he was a somewhat heavier pilot than *Monarch* had been designed for, but a series of ergometer tests proved that his power surpassed that of all other candidates and more than made up for his weight. Frank began a training program to condition his legs and smooth his pedaling stroke.

With both the *Monarch* and the *Bat* flying, word of each team's activities filtered back and forth through the human-powered-vehicle grapevine. The *Bat*, it seemed, was turning out to be underpowered and plagued with energy-storage problems. Meanwhile, the *Monarch* was having trouble turning. We originally designed it to use a technique called "wing warping," pioneered by the Wright brothers, in which the pilot operates controls that pull wires to twist the wing. This proved awkward, however, and the pilot couldn't make the 180-degree turns required by the Kremer course.

Both the *Monarch* and the *Bat* also encountered problems in coupling the pilot's effort with the onboard energy-storage system. All airplanes need extra thrust while taking off and turning. In previous human-powered aircraft, the pilot provided this increased thrust by pedaling faster. But this didn't work with the new

After crossing the finish line to capture the world speed record, Monarch proudly retired to the Boston Science Museum.

models. When the pilot pedaled faster, the electric motor by its very nature actually *reduced* its contribution, and the propeller's thrust remained essentially the same. One solution to this dilemma is a "variable-pitch propeller," which can change the angle, or pitch, at which its blades meet the air and thus vary its thrust. This enables the pilot to control the propeller's thrust by either increasing its pitch or pedaling faster to increase its speed, allowing propeller, pilot, and electric motor to be matched precisely under any conditions. MacCready's team used its experience from a previous solar-powered airplane to fabricate a variable-pitch system for the *Bat* in short order. We couldn't devise one as quickly.

Then, on September 23, the *Monarch* rolled off the runway after landing, nosed over, and suffered damage to the fuselage. Two days later, the *Bionic Bat* flew the Kremer course in 2 minutes 39 seconds—fast enough to claim the prize. Our team canceled any thoughts of repair and took *Monarch* apart. We didn't realize that MacCready's claim was not a sure thing.

The RAeS rejected the claim, for unspecified technical reasons, in November. The action had little immediate impact on the *Monarch* team, however, since the aircraft was already in storage, the weather was growing increasingly hostile, and the volunteers were fully preoccupied with heavy academic workloads.

New Year, New Hope

MacCready's team was determined to win the prize officially, and trade-journal reports predicted imminent success. By January, the *Bat* was again making attempts at the record. However, as time wore on and no new claims emanated from California, the *Monarch* team began to hope for another shot and started thinking about how to redesign the aircraft.

We decided to reconfigure the cockpit so that the pilot would recline slightly rather than sit upright; by lowering the center of gravity, this would prevent noseovers. We replaced "wing warping" with ailerons—movable parts on the wing's trailing edge that made the plane easier to turn. We added a brake to the landing gear. But most important, we added a var-

The *Monarch* team. Front row, from left: Tidhar Shalon and Juan Cruz. Middle row: John Langford, Frank Scarabino, Mark Drela, and Barbara Langford. Back row: Steve Finberg, Scott Clifton, Rick Sheppe, Sean Tavares, Geoff Landis, and James Wilkerson. Absent: John Flynn, Harold Youngren, and faculty advisers Walter Hollister and Edward Crawley.

iable-pitch propeller controlled automatically during flight by sensitive electronics. The new propeller decreased the pilot's physical burden while the automatic "throttle" eased the mental workload.

We planned to have the new "B" version ready to fly by early summer. But at a conference in late February, Paul MacCready explained publicly the reason for the *Bat*'s rejection: its batteries had not been totally discharged before the flight. He also said that the RAeS had added a new rule requiring that the batteries be short-circuited for at least one hour prior to flight. But something else really grabbed our attention. MacCready seemed to hint that his team considered the restrictions impossible to meet and was abandoning stored-energy systems. The team apparently planned to increase the *Bat*'s wingspan and get by on human power alone.

Our team had already evaluated this option, even conducting flight tests, and agreed that MacCready was turning down a blind alley. We decided to accelerate the rebuilding effort and try to have the new *Monarch* ready by spring break, only five weeks away.

We made it. Snow still lined the runway on April 3 as Scarabino eased himself into the recumbent cockpit for *Monarch*'s first tests. He reported great improvement in handling and controllability. The electronic prop-pitch control system worked well, while the ailerons allowed smooth turns. The new *Monarch* flew slightly faster than the original, and consumed slightly less power. The brake proved its value on several occasions. Although bad weather limited flying to only a day or so each week, the flight program proceeded smoothly.

Meanwhile, MacCready's group had stretched the *Bat*'s wingspan to 57 feet. But after several days of testing, the team apparently concluded that switching to human power alone had been a mistake and began work on a new energy-storage system.

Back in Boston, late April brought perfect flying weather. Frank cranked the aircraft through its first 180-degree turn on the 27th. We were almost ready. But before we could shoot for the speed prize, the Kremer rules required the *Monarch* to make a qualifying flight—essentially an untimed journey around the course in the opposite direction to prove that the aircraft could turn in both directions. Fulfilling this requirement took four tries. But on the morning of April 30 official observers certified that Frank had completed the qualifying flight.

Victory at Last

Frank made his first attempt at the speed record on May 3. Following the rules to the letter, we discharged the batteries the night before and short-circuited them for an hour before the flight. Frank pedaled in place to charge the batteries, switched the generator over to become a motor, and took off. Unfortunately, the ground crew had set one of the electronic flight-control systems incorrectly and the aircraft soon stalled. Clearly, everything was going to have to be perfect if we were to set the record.

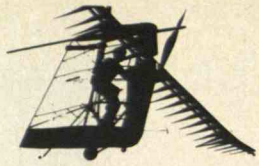
The next three days saw three more tries, including the flight that missed the three-minute mark by only .43 seconds. The tension and excitement were now almost unbearable. We continued to refine the aircraft, sealing every crack and streamlining every protrusion. We ran more bench tests and computer simulations on the energy-storage system, and fine-tuned everything between each flight. We also wrapped tight security around the project—at least as tight as possible in a university—for fear that MacCready's team might learn of what we considered *Monarch*'s imminent success. Meanwhile, final exams scheduled for late May loomed over the project like a Sword of Damocles, especially for the pilot, who was hoping to graduate.

Although *Monarch* could fly in winds up to about 7 miles per hour, we estimated that each mile-per-hour increase added about 10 seconds of flight time to the course. We thus wanted absolute calm, which occurs only at dawn. Using weather data from M.I.T.'s Meteorology Department, we predicted that May 11 would break clear and still.

Team member Mark Drela had "inverted" his daily schedule for several weeks, going to sleep at 10 A.M. and waking at dusk to head for the hangar. At 2 A.M. on this Friday, Mark called out more of the flight crew. Frank was summoned about an hour later. We then checked the wind one last time before contacting the official observers appointed by the RAeS. This was the least pleasant part of the flight routine; it was one thing to rouse a fellow student in the dark of night, but quite another to call a professor or aerospace executive, even though both expected the call.

With its wings wrapped in plastic to keep dew from condensing on them, *Monarch* rolled out shortly after dawn. Team members bundled themselves against the chill, while Frank warmed up on a bicycle. He entered the cockpit at 5:45 A.M., while the crew removed the dead short from the batteries. Frank charged the batteries for seven and a half minutes, reconfigured the aircraft for flight, and donned his helmet. The door zipper jammed briefly, causing the takeoff roll to start late. Frank crossed the starting line roughly 10 minutes and 5 seconds after beginning the charge. The rules gave him 10 minutes, so he was already behind.

He cleared the first two turns with ease, staying about eight feet off the ground entering the long back stretch. From a chase truck following closely behind, a team



member radioed him a steady stream of information on altitude and elapsed time. Frank began the final turn, tracking inside the path of traffic cones and bedsheets laid out to mark his path. He racked *Monarch* into the tightest turn ever attempted, bringing gasps from those in the chase truck, who held their breath to see if the wing could support the load.

Monarch leveled out, very low, and headed straight for the finish line. At 2 minutes and 30 seconds, we began a second-by-second countdown. Frank began a steady but agonizing climb—the cockpit shaking visibly with each powerful stroke. Suddenly, *Monarch* was up and well over the streamer marking the finish line. This time there was no doubt. Shaving more than 10 seconds off his previous time, Frank had completed the course in 2 minutes and 49 seconds. Adding the seconds lost at takeoff, the flight was officially recorded at 2 minutes, 55.72 seconds. The Kremer Prize was M.I.T.'s at last!

The RAeS tentatively approved the record in July and gave its final nod on September 27. By then all the designers had taxied and flown the aircraft. It had already lived longer than expected—we designed it to the edge of needed durability to reduce weight—and *Monarch* proudly retired to the Boston Museum of Science.

MacCready's team recovered from the shock and on July 18 bettered *Monarch*'s time by the required 5 percent, qualifying for the 5,000-pound second prize. In August a German aircraft called *Musculaire*, catching everyone off guard with its sudden appearance, bettered the *Bat*'s time and claimed the third prize. Surprisingly, the *Musculaire* used only human power. The Germans used immaculate construction and a high-tech graphite wing spar spanning more than 72 feet to achieve this impressive performance.

Beyond Monarch

When the RAeS devised the rules of this latest competition, it hoped to encourage development of airplanes that are more practical to build, store, and fly than earlier generations of human-powered aircraft. *Monarch*, the *Bionic Bat*, and the *Musculaire* are steps in this direction, though designers still have a way to go. More than practical ends in themselves, the new aircraft illustrate dramatically what can be done with judicious application of technology.

For example, *Monarch* flies on a mere .5 horsepower, while today's ultralight aircraft need 50 times more power to accomplish essentially the same task. The *Bat* and the *Musculaire* show how composites of graphite and epoxy can yield strong, light-weight structures that don't need wire bracing. The *Monarch* illustrates how advanced electronics can increase system performance and reduce pilot workload. Together these technologies point the way toward low-cost, energy-efficient airplanes that almost anyone will be able to fly.

Nor are these technologies limited to human-powered aircraft. For example, the Department of Defense and the National Aeronautics and Space Administration are both interested in developing aircraft that could serve as "poor-man's satellites." These pilotless planes would loiter at high altitudes for months, surveying the earth or relaying local communications. Since the upper atmosphere is so thin, their wings will have to be very large and light, with structures more akin to human-powered than conventional aircraft. Likewise, the flow of air around the wings will have more in common with that around *Monarch* than with flow around higher-speed aircraft for which scientists have accumulated the most data on aerodynamics.

However, human-powered aircraft will likely make their most important contributions in education. The U.S. aeronautical community is in an awkward position: technology is advancing rapidly on every front, but with sophistication goes increased cost. Manufacturers are thus developing fewer new aircraft, and it has become rare for an individual engineer to work on a project from conception through flight. How, then, can young engineers gain experience?

Most university programs in aeronautics feature a design course in which students' work ends on paper. Yet the chasm between a design study and a final product is enormous. Even in the nineteenth century Otto Lilienthal, the great German glider pioneer, recognized that fact: "To conceive an aircraft is nothing, to build one is very little, but to test and fly an aircraft—that is everything," he said. There is no substitute for experience. Human-powered aircraft are ideally suited to the university environment and can provide students with hands-on, real-life engineering experience that is at the very roots of their profession. □

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trigger a dangerous new round in the conventional arms race in Europe.

A final problem is that several missiles—including the Lance, Pershing II, Tomahawk, and Trident—that U.S. weapons designers regard as likely to deliver conventional munitions deep into Warsaw Pact territory have already been deployed with nuclear warheads. Using them with conventional explosives would only blur the distinction between nuclear and nonnuclear weapons. Should NATO attack with conventionally armed versions of these weapons, the Soviets might believe they were under nuclear attack and respond accordingly. Even if unsure which warheads were installed, the Soviets might assume the worst—with the same tragic result.

Advocates of the new conventional missiles propose technical means to distinguish them from nuclear versions. For instance, the two types can be designed to follow different trajectories or to give off distinctive radar "signatures." But all this effort will be wasted if the Soviets detect NATO preparations for launching missiles and, fearing nuclear attack, launch a preemptive nuclear strike. Also, even if a radar operator at the front detects the distinctive signature of a conventionally loaded missile, communicating that information to higher authorities might not be easy. Even under the best circumstances, the "fog of war" in Europe is expected to overload communications systems on both sides. If NATO launches deep-interdiction attacks on Warsaw Pact command, control, and communications posts, the confusion will be truly severe. The higher military authorities may then follow the worst-case reasoning that so often prevails in such situations.

Alternative Approaches

There are two broad alternatives to acquiring high-technology conventional weapons. The first is to negotiate a reduction in Warsaw Pact forces. While the Mutual and Balanced Force Reduction (MBFR) talks in Vienna have achieved few tangible results, many observers such as Jane Sharp of Cornell University believe that the two sides have made progress in establishing a general framework for reducing conventional forces in Europe. These analysts believe that if the two superpowers gave greater priority to these talks, they could agree to pull back significant numbers of combat forces from the central European front. This would diminish the Soviet-bloc threat to NATO, and hence its need for additional arms.

The second alternative for NATO, rarely considered by alliance officials, is to acquire an array of defensive measures that would not lead to escalation. Robert W. Komer, former undersecretary of defense, and Stephen Canby of the Woodrow Wilson Center in Washington have suggested a number of such measures. They include improving the training and organization of reserve forces, constructing antitank barriers and minefields along the East German border, standardizing NATO weapons so that member nations' armies could fight more effectively together, and prepositioning arms and equipment for use by reinforcements from the United States.

Other analysts have suggested adopting more radical measures, such as training and equipping large numbers of civilian reservists to attack invading forces with short-range PGMs. These strategies, based on the "territorial defense" policies of countries such as Yugoslavia and Switzerland, would theoretically present the Soviets with the daunting task of subduing an aroused and combative population of millions. Such proposals are attracting growing interest among Western European strategists and political leaders.

Admittedly, these alternative strategies face serious obstacles: neither superpower seems committed to making a major effort at the MBFR talks, and the effectiveness of the non-escalatory defense proposals is controversial. Nevertheless, the growing consensus that NATO must reduce its reliance on nuclear weapons has inspired a fruitful search for new approaches to security. It is through this effort, and not through indiscriminate purchases of improved conventional munitions, that Europe is most likely to strengthen its defense without increasing the threat of nuclear annihilation.

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It is no surprise that decision makers like to know the boundaries of problems. However, when managers educated in this environment pursue these boundaries in the milestones of company plans, they run headlong into an equally well-ingrained but different cultural style of problem solving among the biologists. These scientists tend to move away gradually from the bounded problems they encounter as students toward an examination of a nature that holds unlimited surprises. Thus, when they argue with each other, the scientists and managers share no common points of reference.

A Search for Solutions

Cultural differences do make a difference, and they can unmake a company. What can be done to smooth the conflicts and realize the collaborative potential of biotechnology companies? I have five specific suggestions.

☐ The problem of conflicts and lack of communication is a reciprocal one that demands a joint solution. Addressing the issue seriously requires the active participation of both management and scientific staff. Visible leadership from both sides of the fence is essential.

☐ Both groups should examine the flow of communications. Who talks to whom, how often, and about what, and where do they meet? Which people have a lot of cross-group interaction, and which individuals are isolated? Where are the incentives or disincentives to communicate? Increasing access to the media of communication—informal meetings, seminars, memos, electronic media, bulletin boards, and reports—can help. Each company environment has its own character.

☐ Physical spaces should promote interaction between the two groups rather than isolate them. Coffee and lunch rooms, libraries, and meeting spaces should be central to promote informal exchanges, and should come replete with lures—such as coffee, periodicals, and sunlight—to attract people into these spaces.

☐ Each side should be better informed about the other's work. Scientists can explain the basics of their field and their own research to managerial staff. Likewise, managers should explain the firm's financial and contractual relations to the scientists and other staff, and look for ways to bring market planners and lab researchers together. A company history that contains the messy, human details will encourage staff to identify with the company. So will an "annual meeting" of the whole staff, in which the company evaluates its past and introduces future plans. It's also important to solicit input from everyone when making plans—without limiting individuals' contributions to their narrow fields of expertise. Regular social activities that mix people across their boundaries of group membership are important. Genentech, for example, hosts social "ho ho's" every Friday evening.

☐ Managers should discuss their changing goals publicly, and should involve the company's scientific staff in planning major changes. Some executives argue that since scientists will only fight to defend their projects, it's best to keep them in the dark. I believe that such a problem is a symptom of a communications gap, not a universal characteristic of scientists. Increasing scientists' awareness of ongoing financial and marketing considerations gives them a chance to add their expertise to the planning process, as well to prepare for necessary changes. It also helps to avoid some of the shock, anger, and disruption of surprises.

These suggestions should help biotechnology companies build a community out of their organization. Firms that make a serious start will set the stage for an involvement that is essential for long-term integration and success.

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now after three decades, with enormous strides in computer technology, is NC becoming useful for the job shop. Ironically, though it is finally possible—and often more practical—for machinists to program their own tools, management generally continues to give this job to white-collar programmers.

To suggest, as Noble does, that academic engineers had developed NC to remove control from hourly workers doesn't make sense. He impugns individuals' motives where broad societal forces are at work. Oddly, many of his accusations—that M.I.T.'s Servomechanisms Laboratory usurped NC technology from an inventor named John Parsons—only serve to show that the engineers were hardly thinking about labor.

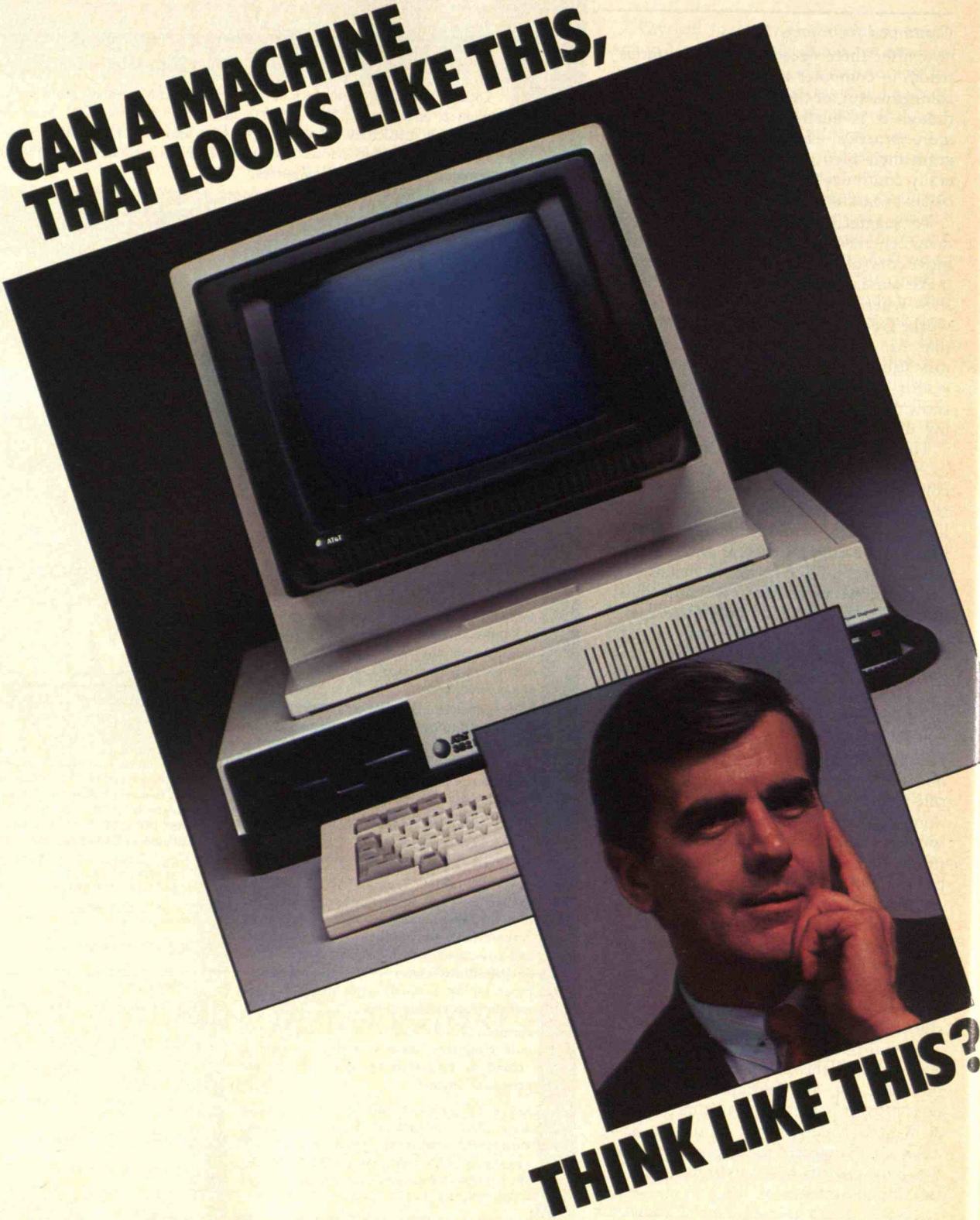
Their motive was to use their computer to explore the fundamentals of automatic control. Controlling a metal-cutting tool is not unlike negotiating a freeway at rush hour: unexpected things happen. Cutting bits become dull, gears wear and lose precision, hard spots crop up in metals. To keep a close tolerance, a machine must sense what it is actually doing and make continual adjustments: it must employ "feedback." The engineers' challenge was to capture the machinist's subtle skills in numbers, electronics, and steel.

Yet as the very name "numerical control" suggests, the broad effects of that Faustian motive mesh well with managers' obsession to control what they see as chaotic factories—costs, inventories, production, workers. None of NC's promoters sought to help competent workers be more productive. If the M.I.T. researchers had been under contract to the International Association of Machinists, they would have produced a far different technology. As anyone who has seen office politics at work knows, productivity has no objective measure that all can agree upon.

Though Noble analyzes only one case study of automation, it is enough to make a general point. If unions do not take an active role in the use of new technology, they lose out, and perhaps the economy does also. It is precisely in countries such as West Germany, where unions do have a say in managerial decisions, that productivity growth has outstripped that in the United States. □

JONATHAN SCHLEFER is a senior editor of Technology Review.

CAN A MACHINE THAT LOOKS LIKE THIS,



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Developmental ACE software has been working as an "assistant" for over two years now to the cable maintenance force of the Southwestern Bell Telephone Company. Every night it monitors and analyzes the performance of cable systems serving over half-a-million customers in several metropolitan areas.

But ACE does more than analyze; it makes recommendations.

The Expert at Work

Unlike a conventional computer system, ACE isn't programmed with all logical answers to all possible problems. Instead, it's given a set of about 500 rules to follow.

ACE can run through the cable records of a city the size of Fort Worth overnight, a job that would take a human up to a week. By collecting its information from other computer programs, detecting recurring patterns, requesting additional data, and testing these data against its expert-derived rules, ACE can often isolate problems much earlier than its human counterparts. It provides information on both specific trouble types and locations—such as a break in cable insulation at the corner of 3rd and Elm. And when ACE has a recommendation to make, rather than generating a mound of paper, it communicates via a CRT.

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AT&T

Continued from page 2

ing the truth, public discussion will get nowhere. Until Moscow stops lying on this issue, with tacit encouragement from many U.S. "space freeze" groups, there is little value in listening to the Soviets at the bargaining table or anywhere else.

James Oberg
Dickinson, Tex.

The authors respond:

Laurence Berger's criticisms are inaccurate. There is some confusion in the public literature over the actual name of the Nike-Ajax. It is sometimes referred to as the Nike-Zeus, the Zeus, or the Ajax. Perhaps this discrepancy accounts for Mr. Berger's comment that the Ajax was originally designed as a surface-to-air missile with a ceiling of no more than 20 miles, and that its conversion to an ASAT role would have been impossible.

The Nike-Ajax missile was armed with a one-megaton nuclear weapon and did have an effective ceiling of about 100 to 150 miles. It became operational in 1963 but was deactivated in 1964 after introduction of the Thor missile, which had a ceiling of 400 miles. Historical evidence suggests that both systems were originally conceived because of concern over possible Soviet use of "orbital bombs." This means that they were intended, *inter alia*, for ASAT use.

As for the SAINT program, preliminary studies were indeed initiated as far back as 1957. The actual demonstration and testing phase of the program began in 1960. By that time, the United States was moving rapidly to develop space-related technology.

Mr. Oberg's arguments are hampered by his anti-Russian emotionalism. Test results for the Soviet ASAT system show a 45 percent overall success rate. Radar-guided systems have a 64 percent overall success rate, but they are susceptible to simple countermeasures. Six optical/infrared-guided systems have all failed. As Air Force Chief of Staff Gen. Lew Allen, Jr., said in Senate testimony in 1979, "I think our general opinion is that we give it [the Russian antisatellite system] a very questionable operational capability for a few launches. In other words, it is a threat that we are worried about. But they have not had a test program that would cause us to believe it is a capable threat." Three of the four Soviet ASAT tests conducted since then have been failures, indicating that Gen. Allen's assessment needs no modification.

In a draft U.N. ASAT Treaty in 1983, the Soviet Union not only offered to forego all ASAT tests; it also called for the dis-

Continued on page 80

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Continued from page 78

mantling of all antisatellite weapons.

The U.S. antisatellite system can be carried by aircraft that can take off from and land on aircraft carriers. The United States also maintains bases in the Indian Ocean and has access to airfields in Australia and the Falklands. Thus, the United States could consider attacking Soviet early-warning satellites at their perigee over the Southern Hemisphere.

The Soviet Union does indeed have some satellites in geosynchronous orbit. However, these civilian "Stationar" satellites are used to relay television and telephone signals to and from Western Europe. As such, they are irrelevant to a discussion of military systems.

Mr. Oberg confuses tactical information, which can be obtained by a variety of means other than low-flying reconnaissance satellites, with strategic information about targets for a U.S. first or retaliatory nuclear strike, which need not be collected in real time. On the other hand, we completely agree with him that in an ASAT exchange, the United States would be at a serious disadvantage. That was the essence of our article: the United States *needs* an ASAT treaty to keep its satellites safe.

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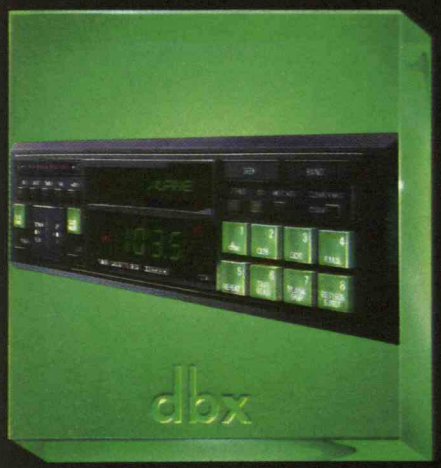

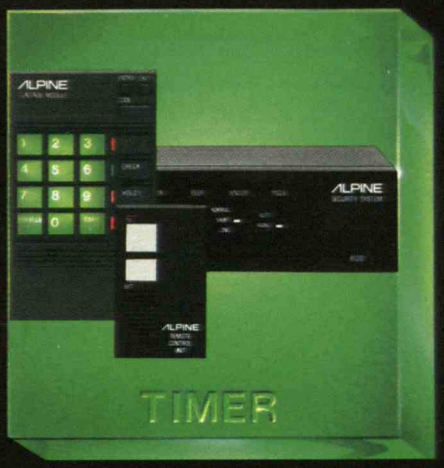

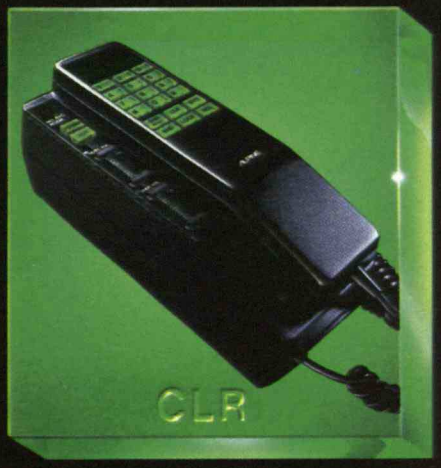

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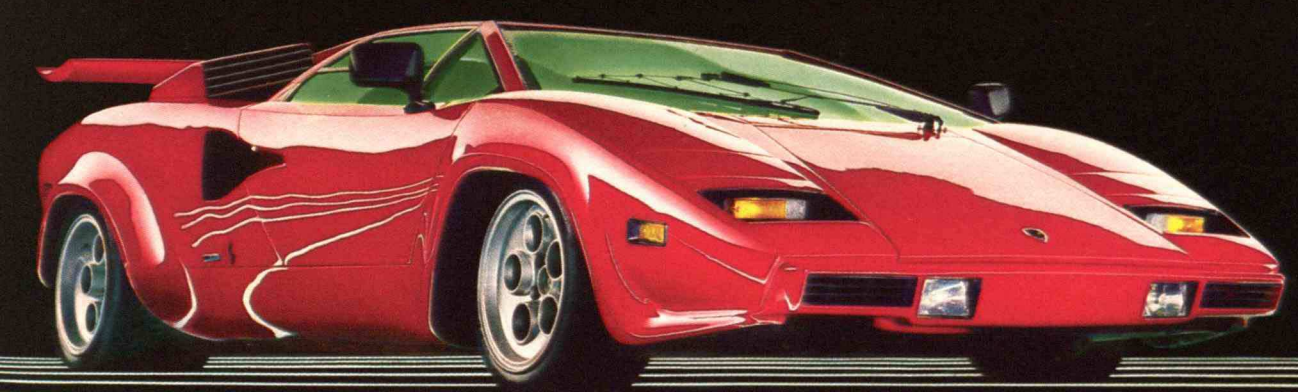

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